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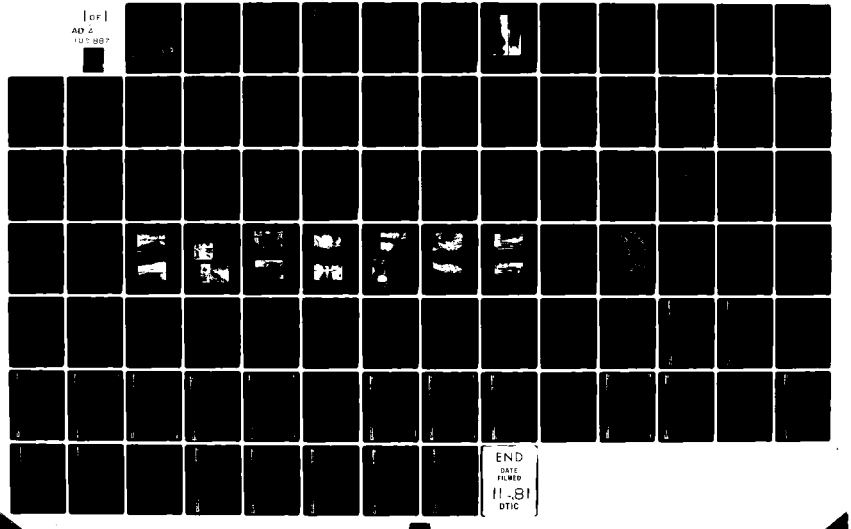

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MISSISSIPPI - SALT - QUINCY RIVER BASIN

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RUSSEL SANDIFER DAM

MARION COUNTY, MISSOURI

MO 10259

9 Final rept.

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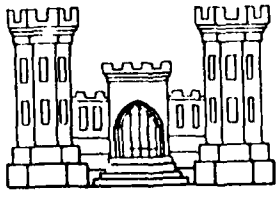
PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM.

Russel Sandifer Dam (MO 10259),
Mississippi - Salt - Quincy River Basin,
Marion County, Missouri. Phase I Inspection
Report.



PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Russell Sandifer Dam (Mo. 10259),
Phase I Inspection Report

This report presents the results of field inspection and evaluation of Russell Sandifer Dam (Mo. 10259). It was prepared under the National Program of Inspection of Non-Federal Dams.

SUBMITTED BY: SIGNED — 29 DEC 1978
Chief, Engineering Division — (Date)

APPROVED BY: SIGNED — 29 DEC 1978
Colonel, CE, District Engineer — (Date)

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Russell Sandifer Dam, Missouri Inv. No. 10259
State Located:	Missouri
County Located:	Marion
Stream:	Unnamed Tributary of the North River
Date of Inspection:	September 26, and October 4, 1978

Russell Sandifer Dam No. Mo. 10259 was inspected using the "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed by the Chief of Engineers, U.S. Army, Washington, D.C., with the help of Federal and state agencies, professional engineering organizations, and private engineers. The resulting guidelines are considered to represent a consensus of the engineering profession.

Based on the criteria in the guidelines, the dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur in the event of failure of the dam. Two farmhouses with associated farm buildings, and one state highway would be subjected to flooding, with possible damage and/or destruction, and possible loss of life. Russell Sandifer Dam is in the small size classification since it is less than 40 feet high and impounds less than 1,000 acre-feet of water.

Our inspection and evaluation indicates that the spillway of Russell Sandifer Dam meets the criteria set forth in the guidelines for a dam having the above size and hazard potential. Russell Sandifer Dam is a small size dam with a high hazard poten-

tial required by the guidelines to pass from one-half the Probable Maximum Flood to the Probable Maximum Flood without overtopping. Considering the small volume of water impounded, and the large floodplain downstream, one-half of the PMF is the appropriate spillway design flood. It was determined the the spillway will pass exactly 50 percent of the Probable Maximum Flood without overtopping the dam. Our evaluation indicates that the spillway will pass the 100-year flood; that is, a flood having a 1 percent chance of being equalled or exceeded during any given year.

The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region.

Other deficiencies noted by by the inspection team were a need for an annual inspection by a qualified professional engineer; lack of a maintenance schedule; embankment sloughing on the upstream slope; trees growing on the upstream slope; and the need for a trashrack over the C.M.P. service spillway inlet. The lack of stability and seepage analysis on record is also a deficiency that should be corrected.

It is recommended that the owner take action to correct or control the deficiencies described above.

RUSSELL SANDIFER DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Russell Sandifer Dam, I.D. No. 10259

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

RUSSELL SANDIFER DAM, Missouri Inv. No. 10259

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

The Dam Inspection Act, Public Law 92-367 of August, 1972, authorizes the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspections. Inspection for the Russell Sandifer Dam was carried out under Contract DACW 43-78-C-0160 to the Department of the Army, St. Louis District, Corps of Engineers, by the engineering firms of Consoer, Townsend & Associated Ltd., and Engineering Consultants, Inc. (A Joint Venture), of St. Louis, Missouri.

b. Purpose of Inspection

The visual inspection of the Russell Sandifer Dam was made on September 26, and October 4, 1978. The purpose of the inspection was to make a general assessment as to the structural integrity and operational adequacy of the dam embankment and its appurtenant structures.

c. Scope of Report

This report summarizes available pertinent data relating to the project; presents a summary of visual observations made during the field inspection; presents an evaluation of hydrologic and hydraulic conditions at the site; presents an evaluation as to the structural adequacy of the various project features; and assesses the general condition of the dam with respect to safety.

It should be noted that reference in this report to left or right abutments is as viewed looking downstream. Where left abutment or left side of the dam is used in this report, this also refers to north abutment or side, and right to the south abutment or side.

d. Evaluation Criteria

Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams", Appendix D. These guidelines were developed with the help of several Federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 Description of the Project

a. Description of Dam and Appurtenances

The dam embankment is a homogeneous earthfill structure. The crest of the embankment has a width of 10-feet, and a length of approximately 335 feet. The crest elevation is set at 606.0 feet above MSL, and the maximum height of the embankment is approximately 28 feet above the minimum streambed elevation.

The upstream slope of the embankment section has a 1V to 1-1/2H slope. The downstream embankment slope is 1V to 2H. The crest of the dam is protected by a light vegetative cover, as is the upstream and downstream embankment slope.

Bedrock at the site and within the vicinity is composed of Mississippian age limestones, siltstones and shales. Thinnly bedded limestone crops out in the ridge on the left side of the site. At this exposure, the attitude of bedding is recorded as N70^{o}W, 5^{o}NE. Soil maps indicate the soil in the vicinity of this dam to be either Putnam or Lindley silt loams, which are glacial in origin.

We understand a cut-off trench was constructed along the length of the embankment, having a depth of 10 feet, a base of 10 feet, and side slopes of 1V to 1H.

There is a service spillway and an emergency spillway for the Russell Sandifer reservoir. The service spillway is an uncontrolled 24-inch C.M.P. which runs from near the north end of the dam through the north hillside toward the North River. The invert of the pipe inlet is at

elevation 600.0 MSL. The original spillway was a smaller C.M.P., which was washed out approximately 10 years ago. Details are not available, due to the fact that there was no formal design of the spillway or dam. Bottom width of the emergency spillway is 25 feet at the narrowest point, with side slopes of 1V to 1H on the left and 1V to 6H on the right. The crest of the emergency spillway is at elevation 602.5 MSL. The spillway channel runs in an easterly direction toward the floodplain, downstream and away from the embankment toe.

The outlet works consists of two 2-inch diameter steel pipes which extend into the reservoir a distance of 30 feet. The pipes are perforated with 1/4-inch diameter holes for a distance of 20 feet from the end of the pipe.

The pipes run from the dam to a point 500 feet downstream of the dam where two 2-inch gate valves are used for control. From this point, the pipes run into the farm area for use as stock water supply.

The reservoir at Russell Sandifer Dam impounds 75 acre-feet of water from a drainage area of 0.188 square miles. The dam and reservoir are shown on the Philadelphia Quadrangle Sheet (7.5 minute series) in Section 25, Township 58 North, Range 8 West.

b. Location

The Russell Sandifer Lake Dam is located on an unnamed tributary of the North River, Marion County, Missouri. The nearest community downstream of the dam is Palmyra, which is roughly 10 miles from Russell Sandifer Lake. The Sandifer Farm is located immediately downstream of the lake.

c. Size Classification

According to the "Recommended Guidelines for Safety Inspection of Dams", by the U.S. Department of the Army, Office of the Chief Engineer, the dam is classified in the dam size category as being "Small" since its storage is less than 1,000 acre-feet. The dam is also classified as "Small" in dam size category because its height is less than 40 feet. The overall size classification is, accordingly, "Small" in size.

d. Hazard Classification

The dam has been classified as having "High" hazard potential in the National Inventory of Dams, on the basis that in the event of failure of the dam or its appurtenances, excessive damage could occur to downstream property, together with the possibility of the loss of life. Our findings concur with the classification. The estimated damage zone extends 1.5 miles downstream of the dam. Within the damage zone are two farmhouses with associated farm buildings belonging to the owner, and one state highway. The floodplain is farmed.

e. Ownership

Russell Sandifer Dam is owned by the Mr. Russell Sandifer, Route 3, Monroe City, Missouri 63456.

f. Purpose of Dam

The purpose of the dam is to impound water for fishing and water for livestock owned by Mr. Sandifer. The impounded water is released by means of two 2-inch diameter outlet pipes.

g. Design and Construction History

Russell Sandifer Dam was designed and constructed by the owner, Russell Sandifer, in 1954 and 1955. According to the owner, the dam was constructed by use of a rubber tire loader, and compacted in 3 to 4 inch lifts. A core trench was dug 10 feet into the foundation to penetrate the topsoil and other foundation material.

The only change since original construction is the addition of a 24-inch diameter corrugated metal pipe spillway tube, which is directed to the North River.

h. Normal Operational Procedures

The dam is used to impound water for use as stock water supply and recreation for the owner. The reservoir level is controlled by rainfall, runoff, evaporation and the water supply requirements of the owner. The reservoir is likely close to full at all times.

1.3 Pertinent Data

a. Drainage Area	120 acres
b. Discharge at Damsite	All discharge at the damsite is through two uncontrolled spillways and two outlet pipes
Estimated experienced maximum flood:	95 cfs
Estimated ungated spillway capacity at maximum pool elevation:	719 cfs

c. Elevation (Feet above MSL)

Top of dam:	606.0
Spillway crest: (Culvert spillway)	600.0
(Earth channel)	602.5
Minimum streambed elevation at centerline of dam:	578.0
Maximum tailwater:	Unknown

d. Reservoir

Length of maximum pool:	1,400 feet ±

e. Storage (Acre-Feet)

Top of dam:	75
Spillway crest (Culvert spillway):	38.6

f. Reservoir Surface (Acres)

Top of dam:	7
Spillway crest: (Culvert spillway)	5

g. Dam

Type:	Earth embankment
Length:	335 feet
Height (maximum):	28 feet
Top width:	10 feet
Side slopes:	
Downstream	1V to 2H
Upstream	1V to 1-1/2H
Zoning:	None, according to owner
Impervious core:	Impervious material for entire embankment
Cutoff:	Core trench, 10-feet wide by 10-feet deep, with 1V to 1H side slopes, according to the owner
Grout curtain:	None

h. Diversion and Regulating Tunnel None

i. Spillway

Type:		Culvert and earth channel
Length of weir:		2-foot diameter C.M.P. culvert and 25-foot wide earth channel
Crest Elevation:	(Culvert)	600
	(Earth channel)	602.5

j. Regulating Outlets

Type:	Two 2-inch diameter steel pipes
Length:	600 feet
Closure:	2-inch diameter cast iron gate valves

SECTION 2: ENGINEERING DATA

2.1 Design

No design data is available for the dam and appurtenant structures.

2.2 Construction

No construction data is available for the dam or appurtenant structures. According to the owner, the dam was built in 1954 and 1955. See Section 1.2g for further details.

2.3 Operation

No operation records for Russell Sandifer Dam are available. According to the owner, a flood occurred in 1973, and approximately 6 inches of water was flowing over the emergency spillway crest.

It is likely that the reservoir is close to full at all times.

2.4 Evaluation

a. Availability

No engineering data is available.

b. Adequacy

The engineering data available is inadequate to aid in evaluating the adequacy of the hydraulic and hydrologic capabilities of the dam for Phase I investigations. The owner should have a survey performed and an as-built set of drawings made for the dam and appurtenant structures.

The lack of engineering data other than design drawings did not allow for a definitive review and evaluation. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing and evaluating design, operation and construction data, but is based primarily on visual inspection, past performance history, and sound engineering judgment.

Seepage analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity

No engineering data is available.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

A visual inspection of Russell Sandifer Lake Dam was made on September 26, and October 4, 1978. The following persons were present during the inspection:

Name	Affiliation	Discipline
Yin Au-Yeung	Engineering Consultants, Inc.	Project Engineer, Hydraulics and Hydrology
David Bramwell	Engineering Consultants, Inc.	Geology
Jon Diebel	Engineering Consultants, Inc.	Soils
John Ismert	Engineering Consultants, Inc.	Mechanical
Kevin Blume	Consoer, Townsend & Assoc., Ltd.	Civil & Structural

Specific observations are discussed below.

b. Dam

The crest and downstream slope of the dam embankment have a thin vegetative cover. However, no serious sloughing or erosion was observed on the crest, downstream slope or abutment contacts.

The upstream slope of the embankment is very steep, and only protected by vegetation. As a result, sloughing of the embankment materials is occurring near the high water mark. This sloughing is aided by cattle traffic on the upstream slope just above the high water mark.

Several trees, including one large tree 18 inches in diameter, are growing on the upstream embankment slope. The large tree is growing approximately 2 vertical feet above the high water mark.

A spring was noted about 30 feet east of the downstream toe, and at the base of the ridge on the right side of the dam. We understand this spring existed prior to construction of the dam, and has not enlarged since impoundment of the reservoir water.

Areas exhibiting cracking, settlement or sliding were not observed on the embankment at any location. Rodent activity also was not observed to any significant degree.

c. Appurtenant Structures

(1) Spillway

The service spillway discharge pipe was free of obstructions and debris, and was in good condition. There was no trashrack of any kind to protect the pipe inlet, and an energy dissipator was not noted at the end of the spillway. Seepage collars were not installed on the C.M.P. pipe. No vegetative growth was observed in the reservoir area near the spillway entrances. Except for minor sloughing of the slope of the left bank of the emergency spillway channel, the emergency spillway is also in good condition.

(2) Outlet Works

The outlet works piping was submerged and could not be observed. The gate valves appeared to be in satisfactory condition.

d. Reservoir Area

The water level was at elevation 599.0 feet above MSL at the time of the inspection.

The reservoir shore in the immediate area of the dam gave no sign of instability. At the higher elevation and upstream from the dam, the watershed area is covered with heavy trees and forest.

e. Downstream Channel

The downstream channel is undefined; there is no downstream channel, as such, immediately downstream from the dam. The emergency spillway discharges into the valley plain and flows along the natural ground slope into the North River.

3.2 Evaluation

The visual inspection did not reveal any items which are sufficiently significant to indicate a need for immediate remedial action.

The following items were observed which could affect the safety of the dam, or which will require maintenance within a reasonable period of time.

1. Embankment sloughing on the steep upstream slope, resulting from wave actions and cattle traffic.

2. Trees growing on the upstream embankment slope.

3. The spring located downstream of the right toe of the dam.

4. The sloughing of the left bank of the spillway discharge channel.

5. Lack of a trashrack over the C.M.P. service spillway inlet.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

Russell Sandifer Dam impounds water from an unnamed tributary of the North River. The water is used for stock water supply and for recreation.

The only operating facility at the lake is the two small waterlines which run from the reservoir to the farm area, approximately 500 feet downstream of the dam. Valves for controlling the flow in these pipes are located in a small pit.

4.2 Maintenance of Dam

The dam is maintained by the owner, who lives in close proximity to the damsite. Maintenance of the dam and appurtenant structures appears to be satisfactory. The upstream slope of the embankment will require some work to prevent the sloughing and steepening of the upstream slope.

4.3 Maintenance of Operating Facilities

Very little maintenance is required with the two small waterlines. The valves appeared to be in satisfactory operating condition.

4.3 Description of Any Warning System in Effect

The inspection team is not aware of any warning system for this dam.

4.5 Evaluation

With the exception of the sloughing on the upstream slope, the operation procedures and maintenance appears to be satisfactory.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design

The Russell Sandifer Dam has a watershed area of approximately 120 acres, of which approximately 50 percent is covered by wooded area. Land gradients in the higher elevations of the watershed average about 3 percent, while the areas surrounding the lake slope at roughly 4 to 5 percent. Russell Sandifer Dam is located on an unnamed tributary of the North River.

Elevations within the watershed range from approximately 600 feet above MSL at the damsite to over 710 feet above MSL in the upper portion of the watershed.

A drainage map showing the watershed area is included in Appendix B.

Evaluation of the hydraulic and hydrologic features of Russell Sandifer Dam was based on criteria set forth in the Corps of Engineers' Recommended Guidelines for Safety Inspection of Dams, and additional guidance provided by the St. Louis District of the Corps of Engineers. The Probable Maximum Flood (PMF) was calculated from the Probable Maximum Precipitation (PMP) using the methods outlined in the U.S. Weather Bureau Publication, Hydrometeorological Report No. 33. The probable maximum storm duration was set at 24 hours, and storm rainfall distribution was based on criteria given in EM 1110-2-1411 (Standard Project Storm). The

SCS triangular hydrograph, transformed to a curvilinear hydrograph, was adopted for developing the unit hydrograph. The derived unit hydrograph is presented in Appendix B.

Initial and infiltration loss rates were applied to the PMP to obtain rainfall excesses. The rainfall excesses were then applied to the unit hydrograph to obtain the PMF hydrograph, utilizing the Corps of Engineers' computer program HEC-1, (Dam Safety Version), which was prepared specifically for dam safety analysis. The computed peak discharge of the PMF and one-half of the PMF are 2,263 cfs and 1,131 cfs, respectively.

Both the PMF and one-half of the PMF inflow hydrographs were routed through the reservoir by the Modified Puls Method, also utilizing the HEC-1 (Dam Safety Version) computer program. The peak outflow discharges for the PMF and one-half of the PMF are 1,963 cfs and 725 cfs, respectively. Only the PMF, when routed through the reservoir, resulted in overtopping of the dam.

The stage-outflow relation for the spillways were prepared from field notes and sketches. The reservoir stage-capacity data were based on the U.S.G.S. quadrangle topographic maps in combination with data given in the National Dam Safety Inventory Table. Reservoir storage capacity included surcharge levels exceeding the top of the dam, and the spillways overtop rating curve assumed that the dam remains intact during routing. In the routing computations, the discharge through the outlet facilities was excluded due to its insignificant magnitude as compared to the spillways' discharge and the PMF. The spillways and overtop rating curve and the reservoir capacity curve are also presented in Appendix B.

From the standpoint of dam safety, the hydrologic design of a dam aims at avoiding overtopping. Overtopping is especially dangerous for an earth dam because the downrush of waters over the crest will erode the dam face and, if continued long enough, will breach the dam embankment and release all the stored water suddenly into the downstream floodplain. The safe hydrologic design of a dam calls for a spillway discharge capability, in combination with an embankment crest height that can handle a very large and exceedingly rare flood without overtopping.

The Corps of Engineers designs its dams to safely pass the Probable Maximum Flood that is estimated could be generated from the upstream watershed. This is the generally accepted criterion for major dams throughout the world, and is the standard for dam safety where overtopping would pose any threat to human life. Although dams that do not fully meet this standard will not be evaluated as "unsafe", the Corps considers the minimum hydrologic requirement for safety for this dam to be the capability to pass one-half of the Probable Maximum Flood without overtopping.

b. Experience Data

No records of reservoir stage or spillway discharge are maintained for this site. However, according to Mr. Sandifer, the maximum reservoir level was about 6 inches over the emergency spillway during the flood in April, 1973.

c. Visual Observations

No seepage was visible in the area of the service spillway discharge pipe. The C.M.P. discharge pipe appears in good condition. However, there is no trashrack at the pipe inlet, nor energy dissipator at the exit. The service spillway releases water into the adjacent drainage basin, and would not affect the safety of the dam. The emergency spillway is in fairly good condition, with the exception of areas of minor sloughing which were noted on the left slope immediately downstream from the spillway crest. Flow through the spillway would be dissipated at the downstream valley plain, and would not pose danger to the structural intergrity of the dam.

d. Overtopping Potential

As indicated in Section 5.1-a., only the Probable Maximum Flood, when routed through the reservoir, resulted in overtopping of the dam. The PMF overtopped the dam crest by 0.96 feet. The total duration of embankment overflow is 0.67 hours during the PMF. The spillways of Russell Sandifer Dam are capable of passing a flood equal to approximately 50 percent of the PMF just before overtopping the dam. The 100-year flood is equal to approximately 15 percent of the PMF, therefore, the spillway will pass the 100-year flood without overtopping of the dam. Since one-half of the PMF is the minimum Spillway Design Flood (SDF) for Russell Sandifer Lake Dam, according to the Recommended Guidelines for Safety Inspection of Dams by the Corps, the spillway capacity of the dam is considered "Adequate".

The effect from rupture of the dam could extend approximately 1.5 miles downstream of the dam. There are two farmhouses with associated farm buildings, and one state highway within the four miles of the floodplain area.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

The upstream embankment slope sloughing is a potentially serious condition which should be repaired. The embankment slope is currently steep and narrow, and further reduction in the embankment section should be prevented. The trees growing on the upstream embankment slope could eventually pose a hazard to the embankment, and should be removed.

The spring located downstream of the dam on the right side should be monitored for changes in quantity, location or color of the water. It is not felt that the spring poses a problem with the stability of the embankment, but monitoring will enable rapid identification of changes which may indicate a hazard.

No signs of structural instability or distress were observed with either spillway. However, there was minor slope sloughing on the left bank near the emergency spillway crest. This condition will probably require repair following a major flood.

The outlet works piping was mostly submerged, and no problems were observed with the portions visible which would jeopardize the safety of the dam.

b. Design and Construction Data

No design or construction data relating to the structural stability of the dam or appurtenant structures are available. No design data relating to seepage and stability analysis are known to exist.

c. Operating Records

No operating records are available relating to the stability of the dam or appurtenant structures. According to the owner, the reservoir remains close to full at all times. The highest water level on the embankment, according to the owner, was 6 inches above the emergency spillway.

d. Post Construction Changes

The 24-inch corrugated metal pipe service spillway was installed in 1974.

e. Seismic Stability

In general, projects located in Seismic Zones 0, 1 and 2 may be assumed to present no hazard from earthquake, provided the static stability conditions are satisfactory, and conventional safety margins exist. Russell Sandifer Lake Dam is located in Seismic Zone 1. A detailed seismic analysis is not felt to be necessary for this embankment.

SECTION 7: ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

It should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team.

It is also important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that an unsafe condition could be detected.

a. Safety

The spillway capacity of Russell Sandifer Dam was found to be "adequate" to safely pass one-half of the PMF, as well as the 100-year flood.

The upstream embankment slope is steep, and exhibits sloughing of embankment materials, due to wave actions and cattle traffic. The slope should be protected by either the addition of compacted earthfill to provide a flatter slope, or riprap.

The trees on the upstream embankment slope pose a potential hazard to the dam. Tree growth is considered unsatisfactory for several reasons: First, trees toppled by wind expose holes that invite rapid erosion and, second, decay of large existing root systems could form channels for eventual piping.

b. Adequacy of Information

Information concerning operation and maintenance of the dam and appurtenant structures is somewhat lacking. It is recommended that the following programs be initiated to help alleviate this problem:

1. Annual inspection of the dam by a professional engineer experienced in the design and construction of earthen dams should be made and this inspection report made a matter of record.

2. Set up a maintenance schedule and log all visits to the dam for operation, repairs and maintenance.

3. Perform seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams".

The performance history and visual inspection findings is felt to be adequate information to support the conclusions presented in this report.

c. Urgency

The remedial actions recommended in Section 7.2 should be accomplished within a reasonable period of time.

d. Necessity for Phase II Inspection

Based on results of the Phase I inspection, a Phase II inspection is not felt to be necessary.

7.2 Remedial Measures

a. Alternatives

Possible alternatives for preventing sloughing on the upstream embankment slope include:

1. Compact earthfill to a minimum slope of 1V to 2-1/2H from the crest to the toe of the embankment.

2. Add riprap to a minimum slope of 1V to 2H from the crest to a point several feet below the normal water mark.

b. O & M Maintenance Procedures

The owner should initiate the following programs.

1. Annual inspection of the dam by a professional engineer experienced in the design and construction of earthen dams.

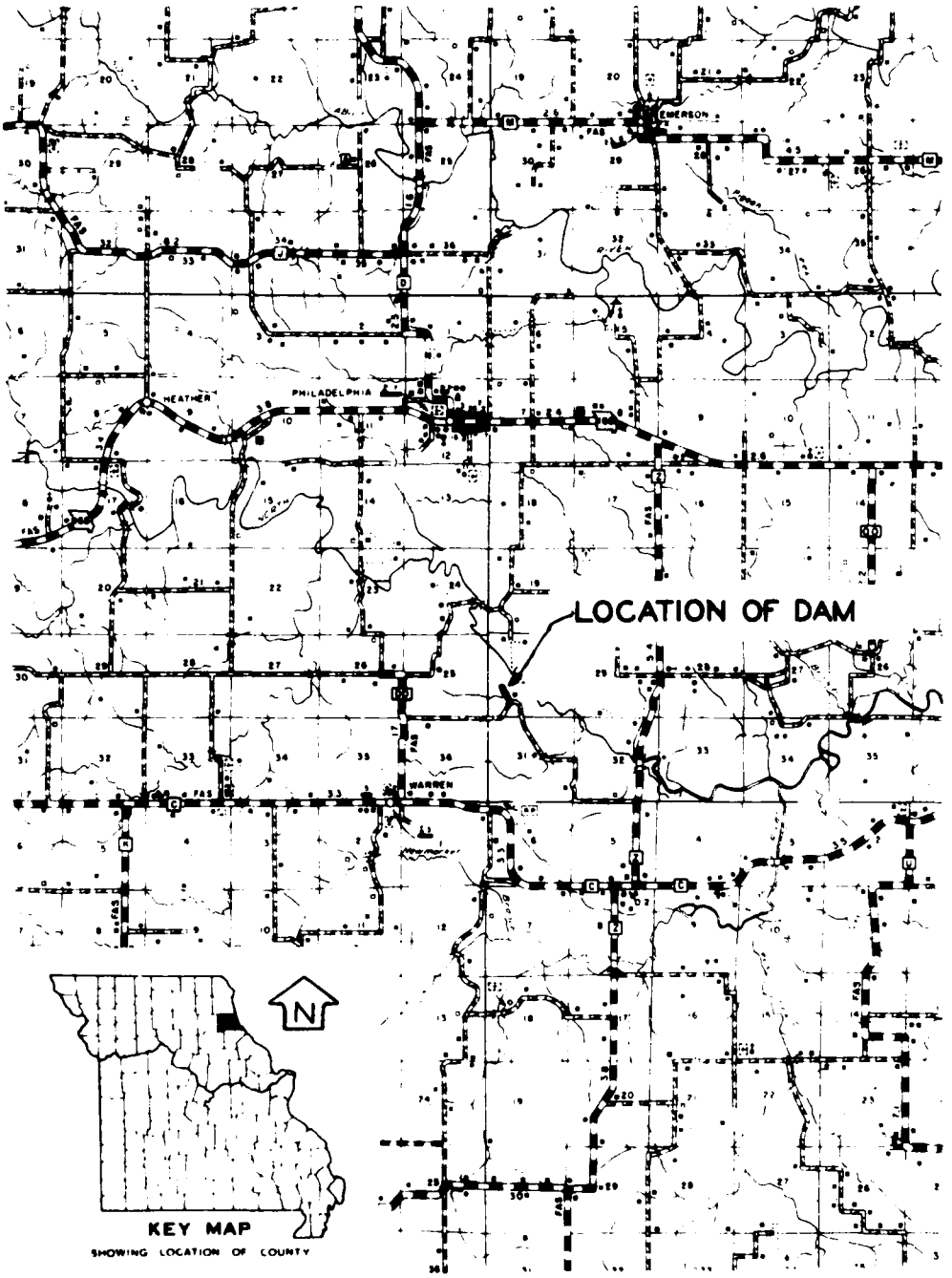
2. Set up a maintenance schedule and log all visits to the dam for operation, repairs and maintenance.

3. Cut the trees on the upstream embankment slope, and prevent future growth.

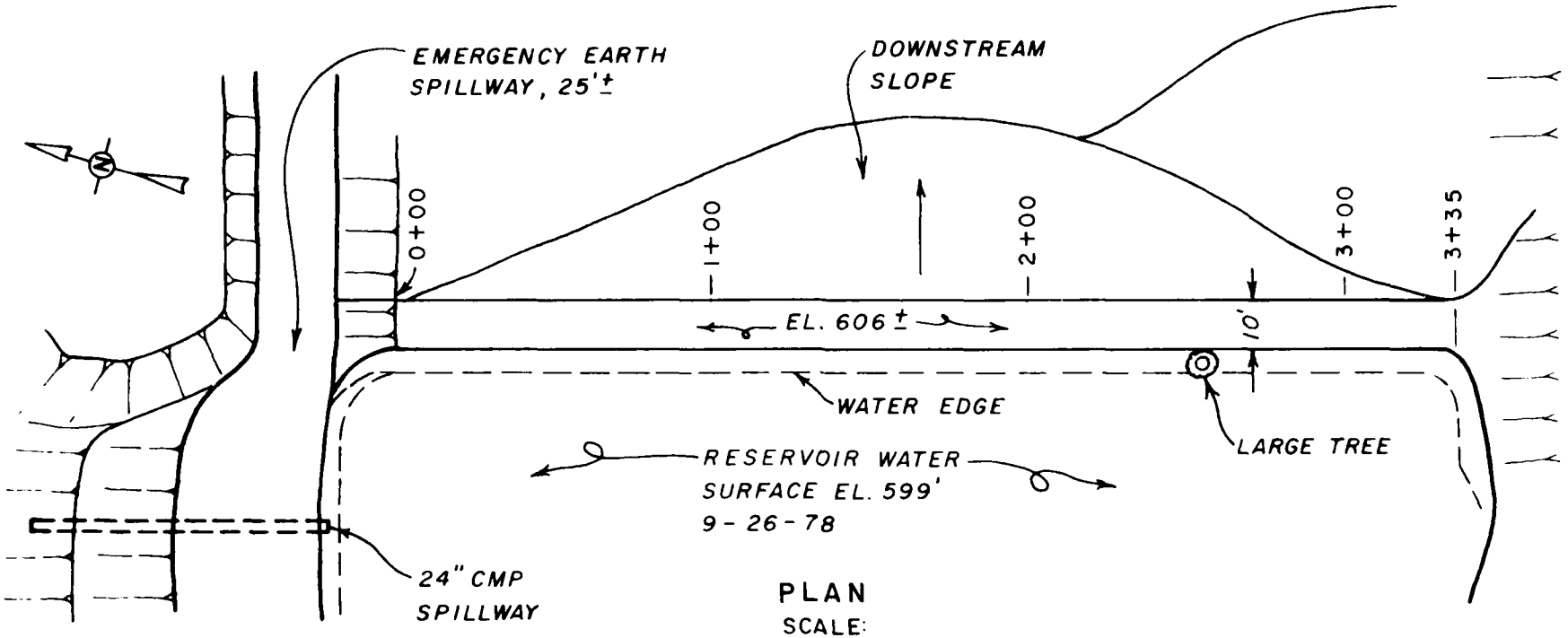
4. Placement of a trashrack over the C.M.P. service spillway inlet.

5. Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of dams.

PLATES

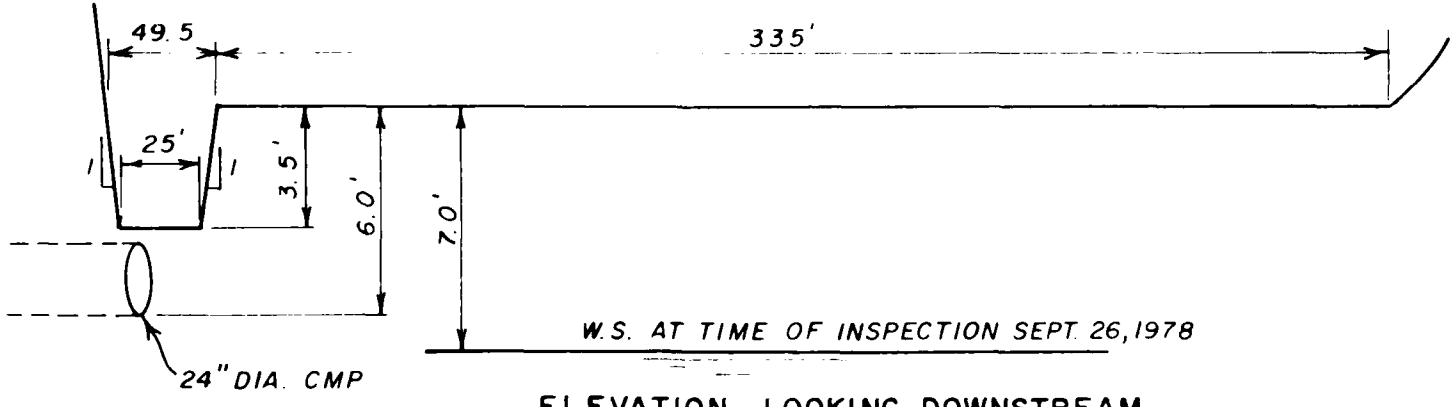


LOCATION MAP
RUSSELL SANDIFER DAM
MARION COUNTY, MISSOURI



PLAN

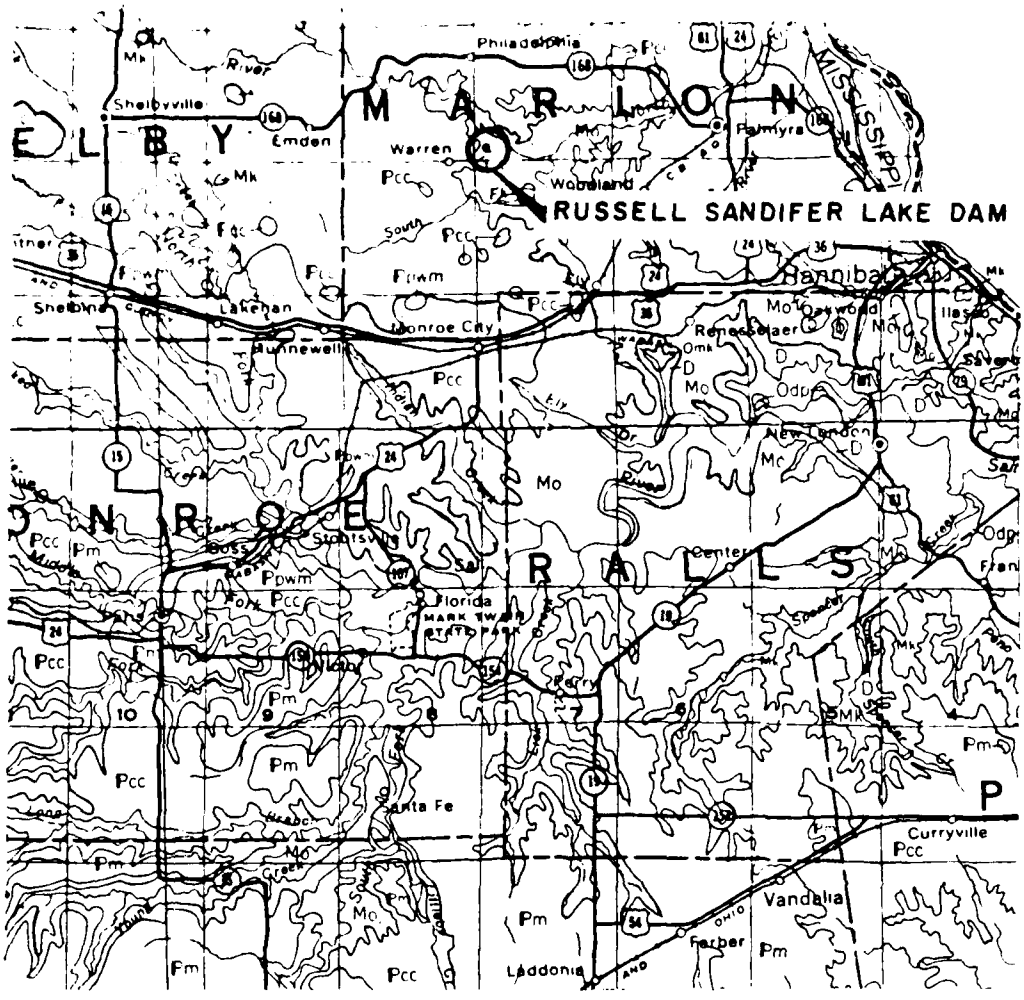
SCALE:
1" = 50' (HORIZONTAL)
1" = 5' (VERTICAL)



ELEVATION - LOOKING DOWNSTREAM

RUSSELL SANDIFER LAKE DAM
RELATIVE ELEVATIONS

2



Explanation

Pennsylvanian System

P_{kc} - Kansas City group: cyclic deposits with numerous limestones.

P_{pwm} - Pleasanton group: sandstone channel member.

P_{m} - Marmaton group: cyclic deposits with limestones.

P_{cc} - Cherokee group: cyclic deposits, predominately shale, sandstone and coal beds.

Mississippian System

M_{m} - sandy, oolitic, fossiliferous, lithographic, or cherty limestones.

M_{o} - cherty, crinoidal limestone, with some shale.

M_{k} - intercalated limestones and shales.

Devonian System

D - limestones and sandstones.

Silurian System

S - limestones with some shale and chert.

Ordovician System

O_{mk} - shale and limestones.

O_{dp} - shale with thin fossiliferous limestone beds and dense limestone.

Reference: Geologic Map of Missouri, 1961, Division of Geological Survey and Water Resources, State of Missouri.

General Geologic Map

APPENDIX A

PHOTOGRAPHS TAKEN DURING INSPECTION

RUSSELL SANDIFER DAM

Photo 1 - View along crest of dam taken at right abutment.

Photo 2 - View of upstream slope of embankment taken at left abutment.

Photo 3 - Picture of upstream embankment slope taken at right abutment.

Photo 4 - Close-up of upstream embankment with large tree growing on slope.

Photo 5 - Close-up of cattle traffic on slope and steepened condition due to cattle and sloughing.

Photo 6 - View of downstream embankment slope taken at left abutment. Note location of spring at top and left of picture.

Photo 7 - Picture of stems used for operation of valves downstream of dam.

Photo 8 - Picture of service spillway pipe and emergency spillway channel.

Photo 9 - Picture of pipe and emergency spillway taken from dam crest.

Photo 10 - Close-up of 24-inch I.D. corrugated metal pipe for service spillway.

Photo 11 - View of discharge channel for service spillway pipe.

Photo 12 - View of emergency spillway discharge channel taken at spillway crest.

Photo 13 - View of emergency spillway discharge channel taken from downstream.

Photo 14 - Picture of left bank of emergency spillway discharge channel.

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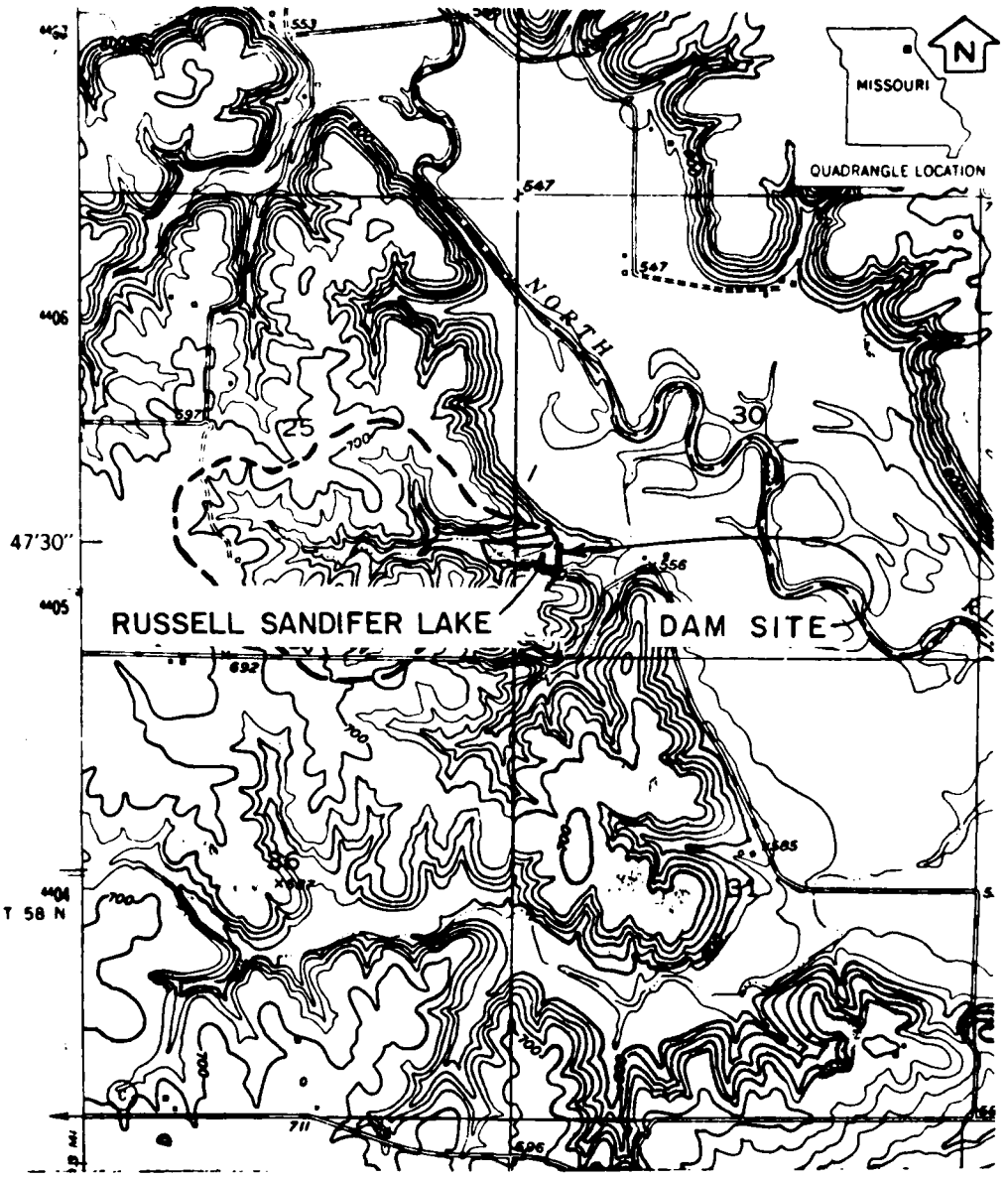
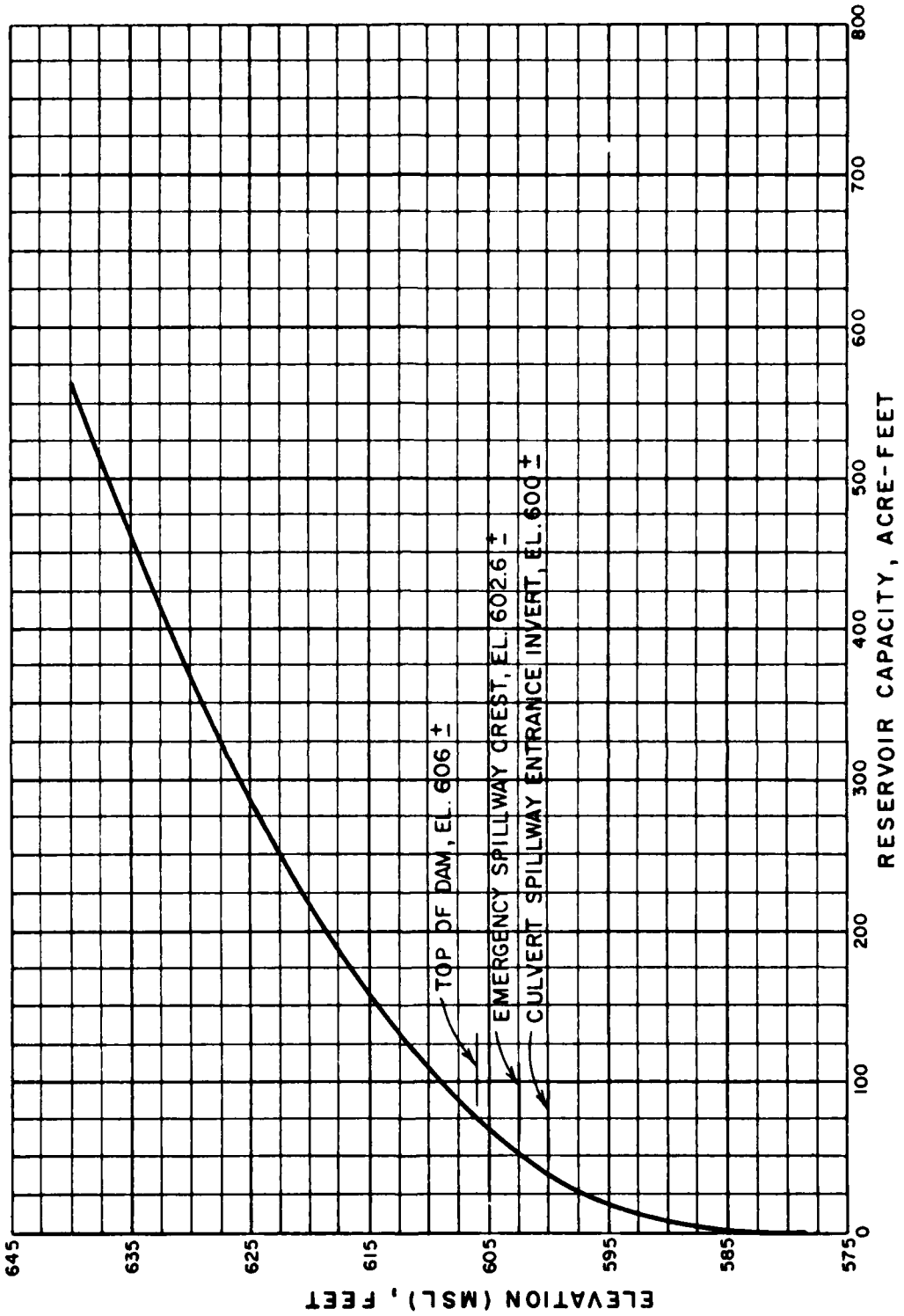
Photo 14 - Picture of left bank of emergency spillway discharge channel.

APPENDIX B

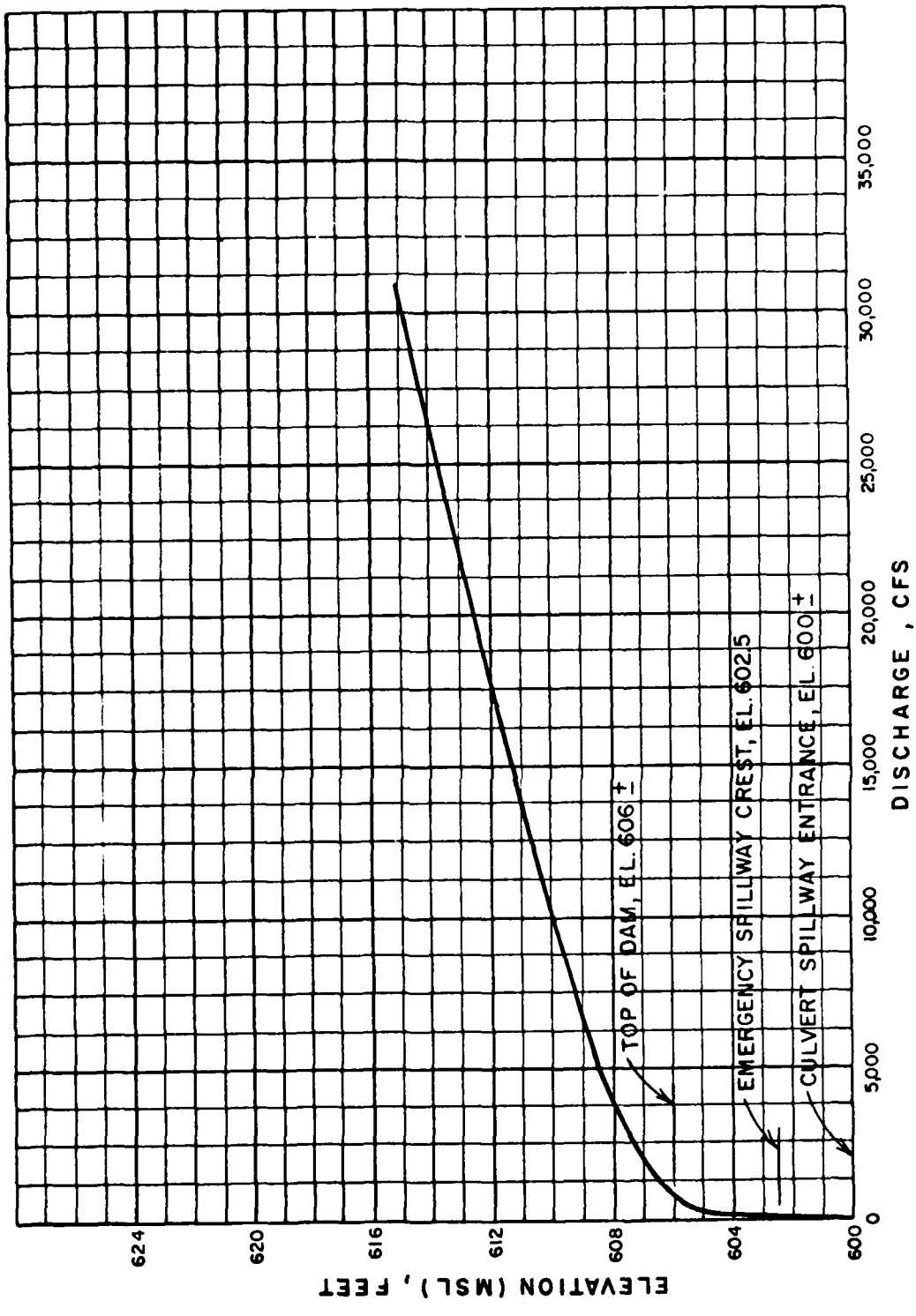
HYDROLOGIC COMPUTATIONS



RUSSELL SANDIFER DAM
DRAINAGE AREA



RUSSELL SANDIFER DAM
RESERVOIR CAPACITY CURVE



RUSSELL SANDIFER DAM
COMBINED SPILLWAYS & OVERTOP RATING CURVE

ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION - MISSOURI — SHEET NO. 1 OF
RUSSELL SANDIFER DAM — JOB NO. 1223-001-1
RESERVOIR AREA CAPACITY — BY KLB — DATE 10-20-78

RUSSEL SANDIFER LAKE DAM

RESERVOIR AREA CAPACITY

ELEV. (FT.) M.S.L.	RESERVOIR SURFACE AREA (ACRES)	INCREMENTAL VOLUME (AC-FT)	TOTAL VOLUME (AC-FT)	REMARKS
578	0	-	0	STREAM BED AT CENTER LINE OF DAM (ASSUMED)
600	5.0	38.6	38.6	UNREGULATED CULVERT ENTRANCE
602.5	5.9	13.6	52.2	
606	7.1	22.8	75.0	TOP OF DAM
620	12.80	139.3	214.3	
640	22.40	352.0	566.3	

The reservoir storage - capacity data were based on the 7½ minute series USGS quadrangle topographic maps in combination with data given in the National Dam Safety Inventory Table.

ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION - MISSOURI — SHEET NO. 1 OF ____

RUSSELL SANDIFER DAM — JOB NO. 1228-001-1

EM. SPILLWAY AND OVERTOP DISCHARGE CAPACITY — BY KLB — DATE 10-19-76

Y_{CA}	T_{CA}	A_{CA}	$V_{CA} = 5.67\sqrt{\frac{A_{CA}}{T_{CA}}}$	$\frac{V_{CA}^2}{2g}$	WS M.S.L. CH, Bottom = $Y_{CA} + \frac{V_{CA}^2}{2g}$	Q_{CA}	H_1	L_1	C_1	$Q_T = Q_{CA} + C_1 L_1 H_1^{3/2}$
0.5	28.5	13.38	3.88	0.23	603.23	52	—	—	—	52
1.0	32.0	28.50	5.35	0.44	604.94	152	—	—	—	152
1.5	35.5	45.38	6.41	0.64	606.64	291	—	—	—	291
2.0	39.0	64.00	7.26	0.82	605.32	465	—	—	—	465
2.5	42.5	84.38	7.99	0.99	605.99	674	—	—	—	674
3.0	46.0	106.50	8.63	1.16	606.66	917	0.66	335	2.70	1404
3.5	49.5	130.38	9.20	1.31	607.31	1200	1.31	335	2.64	2526
4.0	50.0	155.26	9.99	1.55	608.05	1551	4.06	335	2.63	4137
5.0	51.0	205.26	11.39	2.01	609.51	2344	3.51	335	2.63	8483
6.0	52.0	257.26	12.61	2.47	610.97	3244	4.57	335	2.63	13589
8.0	54.0	363.26	14.71	3.36	613.86	5344	7.86	335	2.63	25719

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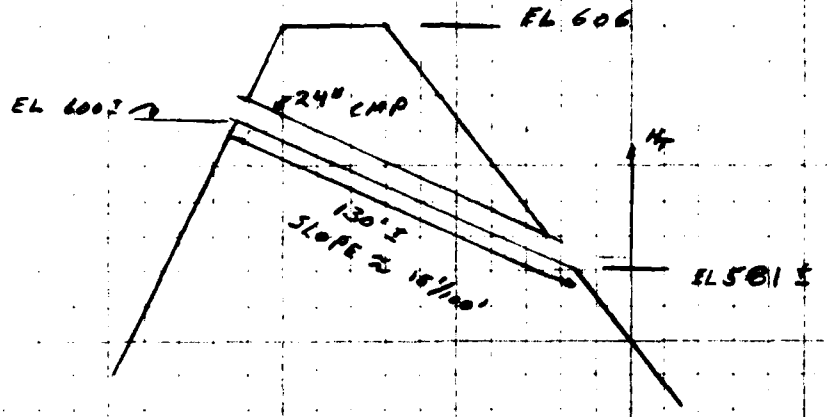
DAM SAFETY INSPECTION - MISSOURI — SHEET NO. 1 OF
RUSSELL SANDIFER DAM — JOB NO. 1223-001-1
CULVERT SPILLWAY CAPACITY — BY KLB DATE 10-20-78



ASSUME 24" CMP, $n = 0.025$, $K_e = 0.6$

$$H_T = \left(1 + K_e + \frac{29 n^2 L}{R^{1.33}}\right) \frac{V^2}{2g}$$

$$H_T = \left(1 + 0.6 + \frac{29 (0.025)^2 \times 130}{0.5^{1.33}}\right) \frac{V^2}{2g}$$

$$H_T = 7.64 \frac{V^2}{2g}$$

$$V = \frac{1}{\sqrt{7.64}} \sqrt{2g H_T}$$

$$V = 0.36 \sqrt{2g H_T}$$

$$Q = V \cdot A = 0.36 \times \pi \cdot 1^2 \times \sqrt{2g H_T}$$

$$\boxed{Q = 9.08 \sqrt{H_T}}$$

ECI-4 ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION - MISSOURI — SHEET NO. 2 OF ____
RUSSELL SANDIFER DAM — JOB NO. 1223-001-1
CULVERT SPILLWAY CAPACITY — BY KLB — DATE 10-20-78

47

UPSTREAM W.S. AT ELEV. 602

$Q = 9.08\sqrt{21.0} = 42$ CFS

UPSTREAM W.S AT ELEV. 603.23

$Q = 9.08\sqrt{22.23} = 43$ CFS

UPSTREAM W.S. AT ELEV. 603.94

$Q = 9.08\sqrt{22.94} = 43$ CFS

UPSTREAM W.S. AT ELEV 604.64

$Q = 9.08\sqrt{23.64} = 44$ CFS

UPSTREAM W.S. AT ELEV 605.32

$Q = 9.08\sqrt{24.32} = 45$ CFS

UPSTREAM W.S. AT ELEV. 605.99

$Q = 9.08\sqrt{24.99} = 45$ CFS

UPSTREAM W.S. AT ELEV. 606.66

$Q = 9.08\sqrt{25.66} = 46$ CFS

UPSTREAM W.S. AT ELEV 607.31

$Q = 9.08\sqrt{26.31} = 47$ CFS

UPSTREAM W.S. AT ELEV 608.05

$Q = 9.08\sqrt{27.05} = 47$ CFS

ECI-4 ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION - MISSOURI — SHEET NO. 3 OF ____

RUSSELL SANDIFER DAM — JOB NO. 1223-001-1

CULVERT SPILLWAY CAPACITY — BY KLB DATE 10-20-78

UPSTREAM W.S. AT ELEV. 609.51

$Q = 9.08\sqrt{28.51} = 48$ CFS.

UPSTREAM W.S. AT ELEV 610.97

$Q = 9.08\sqrt{29.97} = 50$ CFS

UPSTREAM W.S. AT ELEV 613.86

$Q = 9.08\sqrt{32.86} = 52$ CFS

CI-4 ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION - MISSOURI SHEET NO. 4 OF

RUSSEL SANDIFER DAM JOB NO. 1233-001

COMBINED CULVERT, EMERGENCY SPILLWAY AND OVERTOP DISCHARGE CAPACITY BY KLB DATE 12-78

ELEV (FT)	CULVERT DISCHARGE (CFS)	EMERGENCY SPILLWAY DISCHARGE (CFS)	OVERTOP DISCHARGE (CFS)	TOTAL DISCHARGE (CFS)	REMARKS
600.00	0	-	-	0	
602.00	42	-	-	42	
603.23	43	52	-	95	CREST OF EMERGENCY SPILLWAY, EL 603.
603.94	43	152	-	195	
604.64	44	291	-	335	
605.32	45	465	-	510	
605.99	45	674	-	719	TOP OF DAM EL 606
606.66	46	919	485	1450	
607.31	47	1200	1326	2573	
608.35	47	1551	2586	4184	
609.51	48	2344	6139	8531	
610.97	50	3244	10384	13678	
613.86	52	5344	20574	25970	

ECI-4 ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION - MISSOURI — SHEET NO. 1 OF
RUSSELL SANDIFER DAM — JOB NO. 1223-001-1
UNIT HYDROGRAPH PARAMETERS — BY KLB DATE 10-9-78

1. DRAINAGE AREA = 120 AC = 0.19 SQ. MI.

2. LENGTH OF STREAM IN AREA = L = (4.6" x 200'/528') = 0.61 mi

3. DIFFERENCE IN ELEVATION: ΔH

$\Delta H = 710 - 606 = \underline{104 \text{ FT.}}$

4. TIME OF CONCENTRATION

$T_C = \left(\frac{11.9 \times L^3}{\Delta H}\right)^{0.385} = \left(\frac{11.9 \times 0.61^3}{104}\right)^{0.385}$

$\underline{T_C = 0.25 \text{ HR.}}$

5. LAG TIME = $L_t = 0.6 \times T_C$

$L_t = 0.6 \times 0.25 = \underline{0.15 \text{ HR}}$

6. UNIT DURATION

$D = \frac{L_t}{3} = \frac{0.15}{3} = 0.05 \text{ HR.}$

USE D = 5 MIN = 0.083 HR

(MINIMUM DURATION CRITERIA)

7. TIME TO PEAK

$T_p = \frac{D}{2} + 0.6 \times T_C$

$T_p = \frac{0.083}{2} + 0.6 \times 0.25 \text{ HR}$

$\underline{T_p = 0.19 \text{ HR}}$

8. $q_p = \frac{484 \cdot A}{T_p} = \frac{484 \times 0.12}{0.19} = \underline{484.0 \text{ CFS}}$

ECI-4 ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION - Missouri — SHEET NO. 7 OF

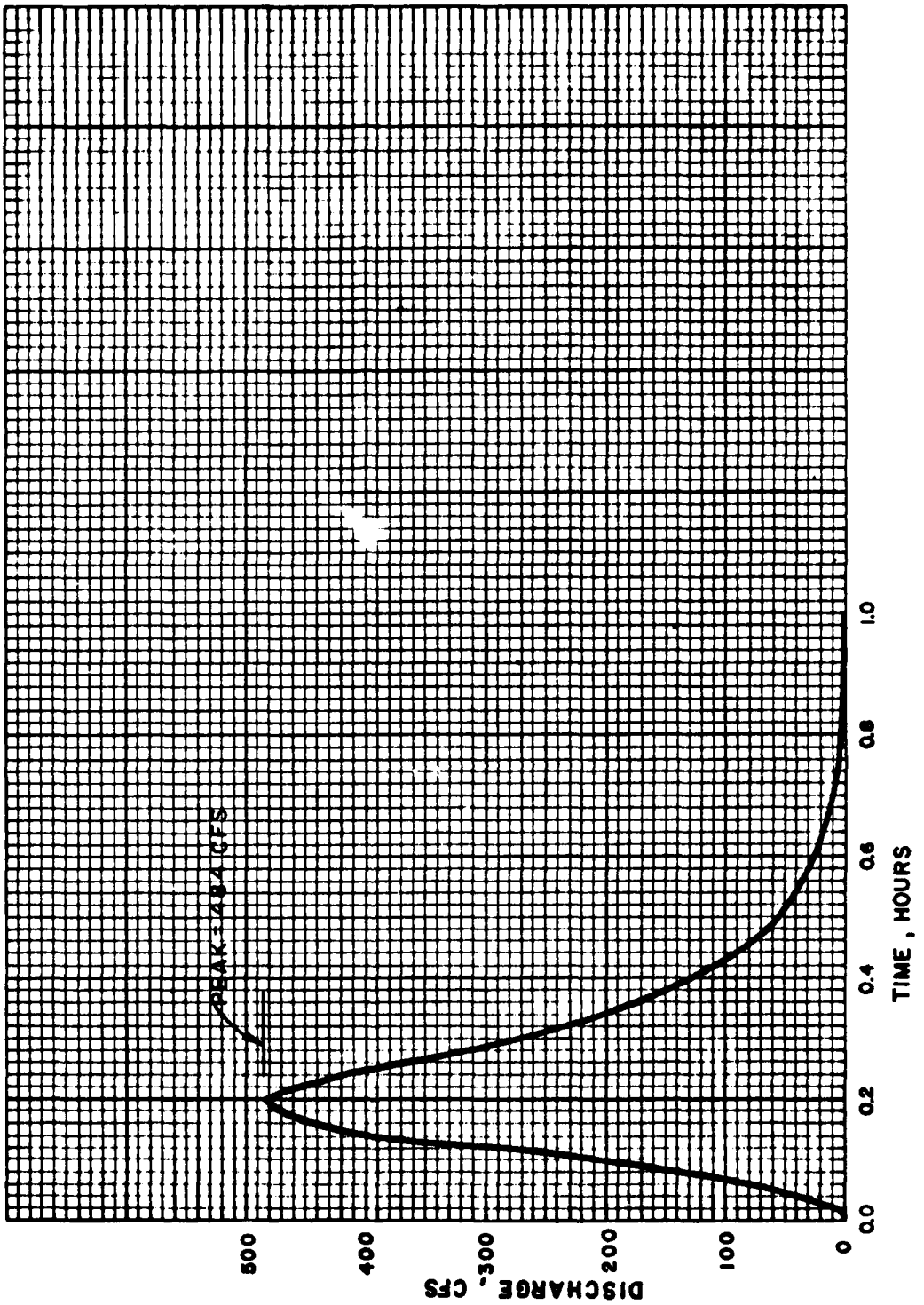
RUSSELL SANDIFER DAM — JOB NO. 1223-001-1

UNIT HYDROGRAPH PARAMETERS — BY KLB DATE 10-9-78

9) CURVILINEAR UNIT HYDROGRAPH

TIME T/Tp	DISCHARGE RATIO q/qp	UNIT HYDROGRAPH TIME, T (HOURS)	UNIT HYDROGRAPH DISCHARGE (CFS)
0.00	0.000	0.00	0.00
0.1	0.015	0.02	7.26
0.2	0.075	0.04	36.30
0.3	0.16	0.06	77.44
0.4	0.28	0.08	135.52
0.5	0.45	0.10	217.80
0.6	0.60	0.11	290.40
0.7	0.77	0.13	372.68
0.8	0.89	0.15	430.76
0.9	0.97	0.17	469.48
1.0	1.00	0.19	484.00
1.1	0.98	0.21	474.32
1.2	0.92	0.23	445.28
1.3	0.84	0.25	406.56
1.4	0.75	0.27	363.00
1.5	0.66	0.29	319.44
1.6	0.56	0.30	271.04
1.8	0.42	0.34	203.28
2.0	0.32	0.38	154.88
2.2	0.24	0.42	116.16
2.4	0.18	0.46	87.12
2.6	0.13	0.49	62.92
2.8	0.098	0.53	47.43
3.0	0.075	0.57	36.30
3.5	0.036	0.67	17.42
4.0	0.018	0.76	8.71
4.5	0.009	0.86	4.36
5.0	0.004	0.95	1.94

124



RUSSELL SANDIFER DAM
5 MINUTE UNIT HYDROGRAPH

RUSSELL SANDIFER LAKE DAM

DETERMINATION OF PMS

1. Determine drainage area of the basin

   D.A. = 0.19 Sq. mi.

2. Determine PMP Index rainfall :

   Location of centroid of basin:

   Long. 91.74° ; Lat.: 39.79°

   → PMP for 200 Sq. mi & 24 hrs duration

   = 24.2" (from Fig 1, HMR NO 33)

3. Determine basin rainfall interms of percentage of PMP Index rainfall for various durations;

   Location: Long. 91.74 ; Lat. 39.79°

   ⇒ Zone 7

Duration (Hrs.)	Percent of Index rainfall (%)	Total rainfall (Inches)	Rainfall increments (Inches)	Duration of increment (Hrs.)
6	100	24.2	24.2	6
12	120	29.0	4.8	6
24	130	31.5	2.5	12

ECI-4 ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION / MISSOURI — SHEET NO. 1 OF
RUSSELL SANDIFER DAM — JOB NO. 1223-001
100-YEAR FLOOD BY REGRESSION EQUATION — BY MAS DATE 10-20-78

RUSSELL SANDIFER LAKE DAM

100-YEAR FLOOD BY REGRESSION EQUATION

Regression equation for 100-yr flood for Missouri:

$$Q_{100} = 85.1 A^{0.934} A^{-0.02} S^{0.576}$$

where A = drainage area in Sq. mi.

S = main channel slope ft./mi.

(Avg. slope between 0.1L & 0.85L)

For Russell Sandifer Lake Dam:

A = 120 acres = 0.19 Sq. mi.

S = 83 ft. / 0.46 mi = 180.43 ft/mi.

$$Q_{100} = 85.1 (0.19)^{0.934} (0.19)^{-0.02} (180.43)^{0.576}$$

$$= \underline{\underline{341 \text{ cfs}}}$$

HEC1DB INPUT DATA

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  3 AUG 78
**********
     1          A                    DAM SAFETY INSPECTION - MISSOURI
     2          A                       RUSSEL SANDIFER      DAM
     3          A          PMF AND 50 PERCENT PMF DETERMINATION AND ROUTING
     4          R    300      0      5      0      0      0      0      0      0      0
     5          R1     5
     6          T      1      2      1
     7          J1   1.0    0.5
     8          K      0      7                                    1
     9          K1     INPUT PMP INDEX PRECIPITATION AND RATIOS, INPUT SCS UNIT HYDROGRAPH
    10          M      1     -1   0.19             0.19    1.0
    11          P           24.20    100     120    130
    12          T                                             0.85   0.07
    13          U     13
    14          U1   0.0    150.    484.    405.    215.    110.     55.    35.    15.    10.
    15          U2     5.     2.      0.
    16          X      0.     0.      1
    17          K      1      7                      2              1
    18          K1       ROUTE HYDROGRAPH THROUGH RUSSEL SANDIFER LAKE DAM
    19          Y                            1      1
    20          Y1     1                                      -600.    -1
    21          Y4600.00  602.00  603.23  603.94  604.64  605.32  605.99  606.66  607.31  608.35
    22          Y4609.51  610.97  613.86
    23          Y5     0.     42.     95.    195.    335.    510.    719.   1450.   2573.   4184.
    24          Y5  8531.  13678.  25970.
    25          $$   0.0    38.6    52.2    75.0   214.3   566.3
    26          $E   578.    600.    602.5   606.    620.    640.
    27          $$600.00
    28          $D606.00
    29          K     99
```

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT	7
ROUTE HYDROGRAPH TO	7

END OF NETWORK

INFLOW PMF AND ONE-HALF PMF HYDROGRAPHS

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION  JULY 1978
  LAST MODIFICATION  3 AUG 78
**********

 RUN  DATE= 78/10/25.
      TIME= 12.32.38.
```

DAM SAFETY INSPECTION - MISSOURI
RUSSEL SANDIFER DAM
PMF AND 50 PERCENT PMF DETERMINATION AND ROUTING

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRIC	IPLT	IPRT	NSTAN
300	0	5	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 2 LRTIO= 1

RTIOS= 1.00 .50

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INPUT PMP INDEX PRECIPITATION AND RATIOS, INPUT SCS UNI

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
7	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	-1	.19	0.00	.19	1.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	24.20	100.00	120.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	.85	.07	0.00	0.00

GIVEN UNIT GRAPH, NUMGO= 13

0.	150.	488.	405.	215.	110.	55.	35.	15.	10.
5.	2.	0.							

UNIT GRAPH TOTALS 1486. CFS OR 1.01 INCHES OVER THE AREA

RECESSION DATA

STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

END-OF-PERIOD FLOW

MO,DA	HR,MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO,DA	HR,MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1,01	,05	1	.01	0.00	.01	0.	1,01	12,35	151	.20	.20	.01	282.

1.01	.10	2	.01	0.00	.01	0.	1.01	12.40	152	.20	.20	.01	287.
1.01	.15	3	.01	0.00	.01	0.	1.01	12.45	153	.20	.20	.01	289.
1.01	.20	4	.01	0.00	.01	0.	1.01	12.50	154	.20	.20	.01	290.
1.01	.25	5	.01	0.00	.01	0.	1.01	12.55	155	.20	.20	.01	291.
1.01	.30	6	.01	0.00	.01	0.	1.01	13.00	156	.20	.20	.01	291.
1.01	.35	7	.01	0.00	.01	0.	1.01	13.05	157	.24	.24	.01	291.
1.01	.40	8	.01	0.00	.01	0.	1.01	13.10	158	.24	.24	.01	297.
1.01	.45	9	.01	0.00	.01	0.	1.01	13.15	159	.24	.24	.01	317.
1.01	.50	10	.01	0.00	.01	0.	1.01	13.20	160	.24	.24	.01	333.
1.01	.55	11	.01	0.00	.01	0.	1.01	13.25	161	.24	.24	.01	342.
1.01	1.00	12	.01	0.00	.01	0.	1.01	13.30	162	.24	.24	.01	346.
1.01	1.05	13	.01	0.00	.01	0.	1.01	13.35	163	.24	.24	.01	348.
1.01	1.10	14	.01	0.00	.01	0.	1.01	13.40	164	.24	.24	.01	350.
1.01	1.15	15	.01	0.00	.01	0.	1.01	13.45	165	.24	.24	.01	350.
1.01	1.20	16	.01	0.00	.01	0.	1.01	13.50	166	.24	.24	.01	351.
1.01	1.25	17	.01	0.00	.01	0.	1.01	13.55	167	.24	.24	.01	351.
1.01	1.30	18	.01	0.00	.01	0.	1.01	14.00	168	.24	.24	.01	351.
1.01	1.35	19	.01	0.00	.01	0.	1.01	14.05	169	.30	.30	.01	351.
1.01	1.40	20	.01	0.00	.01	0.	1.01	14.10	170	.30	.30	.01	360.
1.01	1.45	21	.01	0.00	.01	0.	1.01	14.15	171	.30	.30	.01	389.
1.01	1.50	22	.01	0.00	.01	0.	1.01	14.20	172	.30	.30	.01	414.
1.01	1.55	23	.01	0.00	.01	0.	1.01	14.25	173	.30	.30	.01	427.
1.01	2.00	24	.01	0.00	.01	0.	1.01	14.30	174	.30	.30	.01	433.
1.01	2.05	25	.01	0.00	.01	0.	1.01	14.35	175	.30	.30	.01	437.
1.01	2.10	26	.01	0.00	.01	0.	1.01	14.40	176	.30	.30	.01	439.
1.01	2.15	27	.01	0.00	.01	0.	1.01	14.45	177	.30	.30	.01	440.
1.01	2.20	28	.01	0.00	.01	0.	1.01	14.50	178	.30	.30	.01	440.
1.01	2.25	29	.01	0.00	.01	0.	1.01	14.55	179	.30	.30	.01	441.
1.01	2.30	30	.01	0.00	.01	0.	1.01	15.00	180	.30	.30	.01	441.
1.01	2.35	31	.01	0.00	.01	0.	1.01	15.05	181	.18	.18	.01	441.
1.01	2.40	32	.01	0.00	.01	0.	1.01	15.10	182	.37	.36	.01	423.
1.01	2.45	33	.01	0.00	.01	0.	1.01	15.15	183	.37	.36	.01	393.
1.01	2.50	34	.01	0.00	.01	0.	1.01	15.20	184	.55	.55	.01	434.
1.01	2.55	35	.01	0.00	.01	0.	1.01	15.25	185	.64	.64	.01	511.
1.01	3.00	36	.01	0.00	.01	0.	1.01	15.30	186	1.56	1.56	.01	640.
1.01	3.05	37	.01	0.00	.01	0.	1.01	15.35	187	2.57	2.57	.01	911.
1.01	3.10	38	.01	0.00	.01	0.	1.01	15.40	188	1.01	1.01	.01	1590.
1.01	3.15	39	.01	0.00	.01	0.	1.01	15.45	189	.64	.64	.01	2263.
1.01	3.20	40	.01	0.00	.01	0.	1.01	15.50	190	.55	.55	.01	2080.
1.01	3.25	41	.01	0.00	.01	0.	1.01	15.55	191	.37	.36	.01	1586.
1.01	3.30	42	.01	0.00	.01	0.	1.01	16.00	192	.37	.36	.01	1198.
1.01	3.35	43	.01	0.00	.01	0.	1.01	16.05	193	.28	.28	.01	912.
1.01	3.40	44	.01	0.00	.01	0.	1.01	16.10	194	.28	.28	.01	729.
1.01	3.45	45	.01	0.00	.01	0.	1.01	16.15	195	.28	.28	.01	588.
1.01	3.50	46	.01	0.00	.01	0.	1.01	16.20	196	.28	.28	.01	507.
1.01	3.55	47	.01	0.00	.01	0.	1.01	16.25	197	.28	.28	.01	461.
1.01	4.00	48	.01	0.00	.01	0.	1.01	16.30	198	.28	.28	.01	434.
1.01	4.05	49	.01	0.00	.01	0.	1.01	16.35	199	.28	.28	.01	421.
1.01	4.10	50	.01	0.00	.01	0.	1.01	16.40	200	.28	.28	.01	415.
1.01	4.15	51	.01	0.00	.01	0.	1.01	16.45	201	.28	.28	.01	413.
1.01	4.20	52	.01	0.00	.01	0.	1.01	16.50	202	.28	.28	.01	411.
1.01	4.25	53	.01	0.00	.01	0.	1.01	16.55	203	.28	.28	.01	411.
1.01	4.30	54	.01	0.00	.01	0.	1.01	17.00	204	.28	.28	.01	411.
1.01	4.35	55	.01	0.00	.01	0.	1.01	17.05	205	.22	.22	.01	411.
1.01	4.40	56	.01	0.00	.01	0.	1.01	17.10	206	.22	.22	.01	402.
1.01	4.45	57	.01	0.00	.01	0.	1.01	17.15	207	.22	.22	.01	373.
1.01	4.50	58	.01	0.00	.01	0.	1.01	17.20	208	.22	.22	.01	348.
1.01	4.55	59	.01	0.00	.01	0.	1.01	17.25	209	.22	.22	.01	335.
1.01	5.00	60	.01	0.00	.01	0.	1.01	17.30	210	.22	.22	.01	328.
1.01	5.05	61	.01	0.00	.01	0.	1.01	17.35	211	.22	.22	.01	329.

1.01	5.10	62	.01	0.00	.01	0.	1.01	17.40	212	.22	.22	.01	323.
1.01	5.15	63	.01	0.00	.01	0.	1.01	17.45	213	.22	.22	.01	322.
1.01	5.20	64	.01	.01	.01	0.	1.01	17.50	214	.22	.22	.01	321.
1.01	5.25	65	.01	.01	.01	1.	1.01	17.55	215	.22	.22	.01	321.
1.01	5.30	66	.01	.01	.01	4.	1.01	18.00	216	.22	.22	.01	321.
1.01	5.35	67	.01	.01	.01	7.	1.01	18.05	217	.02	.01	.01	321.
1.01	5.40	68	.01	.01	.01	9.	1.01	18.10	218	.02	.01	.01	291.
1.01	5.45	69	.01	.01	.01	10.	1.01	18.15	219	.02	.01	.01	193.
1.01	5.50	70	.01	.01	.01	11.	1.01	18.20	220	.02	.01	.01	111.
1.01	5.55	71	.01	.01	.01	11.	1.01	18.25	221	.02	.01	.01	68.
1.01	6.00	72	.01	.01	.01	11.	1.01	18.30	222	.02	.01	.01	46.
1.01	6.05	73	.07	.06	.01	11.	1.01	18.35	223	.02	.01	.01	35.
1.01	6.10	74	.07	.06	.01	19.	1.01	18.40	224	.02	.01	.01	28.
1.01	6.15	75	.07	.06	.01	45.	1.01	18.45	225	.02	.01	.01	25.
1.01	6.20	76	.07	.06	.01	67.	1.01	18.50	226	.02	.01	.01	23.
1.01	6.25	77	.07	.06	.01	79.	1.01	18.55	227	.02	.01	.01	22.
1.01	6.30	78	.07	.06	.01	85.	1.01	19.00	228	.02	.01	.01	21.
1.01	6.35	79	.07	.06	.01	88.	1.01	19.05	229	.02	.01	.01	21.
1.01	6.40	80	.07	.06	.01	90.	1.01	19.10	230	.02	.01	.01	21.
1.01	6.45	81	.07	.06	.01	90.	1.01	19.15	231	.02	.01	.01	21.
1.01	6.50	82	.07	.06	.01	91.	1.01	19.20	232	.02	.01	.01	21.
1.01	6.55	83	.07	.06	.01	91.	1.01	19.25	233	.02	.01	.01	21.
1.01	7.00	84	.07	.06	.01	91.	1.01	19.30	234	.02	.01	.01	21.
1.01	7.05	85	.07	.06	.01	91.	1.01	19.35	235	.02	.01	.01	21.
1.01	7.10	86	.07	.06	.01	91.	1.01	19.40	236	.02	.01	.01	21.
1.01	7.15	87	.07	.06	.01	91.	1.01	19.45	237	.02	.01	.01	21.
1.01	7.20	88	.07	.06	.01	91.	1.01	19.50	238	.02	.01	.01	21.
1.01	7.25	89	.07	.06	.01	91.	1.01	19.55	239	.02	.01	.01	21.
1.01	7.30	90	.07	.06	.01	91.	1.01	20.00	240	.02	.01	.01	21.
1.01	7.35	91	.07	.06	.01	91.	1.01	20.05	241	.02	.01	.01	21.
1.01	7.40	92	.07	.06	.01	91.	1.01	20.10	242	.02	.01	.01	21.
1.01	7.45	93	.07	.06	.01	91.	1.01	20.15	243	.02	.01	.01	21.
1.01	7.50	94	.07	.06	.01	91.	1.01	20.20	244	.02	.01	.01	21.
1.01	7.55	95	.07	.06	.01	91.	1.01	20.25	245	.02	.01	.01	21.
1.01	8.00	96	.07	.06	.01	91.	1.01	20.30	246	.02	.01	.01	21.
1.01	8.05	97	.07	.06	.01	91.	1.01	20.35	247	.02	.01	.01	21.
1.01	8.10	98	.07	.06	.01	91.	1.01	20.40	248	.02	.01	.01	21.
1.01	8.15	99	.07	.06	.01	91.	1.01	20.45	249	.02	.01	.01	21.
1.01	8.20	100	.07	.06	.01	91.	1.01	20.50	250	.02	.01	.01	21.
1.01	8.25	101	.07	.06	.01	91.	1.01	20.55	251	.02	.01	.01	21.
1.01	8.30	102	.07	.06	.01	91.	1.01	21.00	252	.02	.01	.01	21.
1.01	8.35	103	.07	.06	.01	91.	1.01	21.05	253	.02	.01	.01	21.
1.01	8.40	104	.07	.06	.01	91.	1.01	21.10	254	.02	.01	.01	21.
1.01	8.45	105	.07	.06	.01	91.	1.01	21.15	255	.02	.01	.01	21.
1.01	8.50	106	.07	.06	.01	91.	1.01	21.20	256	.02	.01	.01	21.
1.01	8.55	107	.07	.06	.01	91.	1.01	21.25	257	.02	.01	.01	21.
1.01	9.00	108	.07	.06	.01	91.	1.01	21.30	258	.02	.01	.01	21.
1.01	9.05	109	.07	.06	.01	91.	1.01	21.35	259	.02	.01	.01	21.
1.01	9.10	110	.07	.06	.01	91.	1.01	21.40	260	.02	.01	.01	21.
1.01	9.15	111	.07	.06	.01	91.	1.01	21.45	261	.02	.01	.01	21.
1.01	9.20	112	.07	.06	.01	91.	1.01	21.50	262	.02	.01	.01	21.
1.01	9.25	113	.07	.06	.01	91.	1.01	21.55	263	.02	.01	.01	21.
1.01	9.30	114	.07	.06	.01	91.	1.01	22.00	264	.02	.01	.01	21.
1.01	9.35	115	.07	.06	.01	91.	1.01	22.05	265	.02	.01	.01	21.
1.01	9.40	116	.07	.06	.01	91.	1.01	22.10	266	.02	.01	.01	21.
1.01	9.45	117	.07	.06	.01	91.	1.01	22.15	267	.02	.01	.01	21.
1.01	9.50	118	.07	.06	.01	91.	1.01	22.20	268	.02	.01	.01	21.
1.01	9.55	119	.07	.06	.01	91.	1.01	22.25	269	.02	.01	.01	21.
1.01	10.00	120	.07	.06	.01	91.	1.01	22.30	270	.02	.01	.01	21.
1.01	10.05	121	.07	.06	.01	91.	1.01	22.35	271	.02	.01	.01	21.

1.01	10.10	122	.07	.06	.01	91.	1.01	22.40	272	.02	.01	.01	21.
1.01	10.15	123	.07	.06	.01	91.	1.01	22.45	273	.02	.01	.01	21.
1.01	10.20	124	.07	.06	.01	91.	1.01	22.50	274	.02	.01	.01	21.
1.01	10.25	125	.07	.06	.01	91.	1.01	22.55	275	.02	.01	.01	21.
1.01	10.30	126	.07	.06	.01	91.	1.01	23.00	276	.02	.01	.01	21.
1.01	10.35	127	.07	.06	.01	91.	1.01	23.05	277	.02	.01	.01	21.
1.01	10.40	128	.07	.06	.01	91.	1.01	23.10	278	.02	.01	.01	21.
1.01	10.45	129	.07	.06	.01	91.	1.01	23.15	279	.02	.01	.01	21.
1.01	10.50	130	.07	.06	.01	91.	1.01	23.20	280	.02	.01	.01	21.
1.01	10.55	131	.07	.06	.01	91.	1.01	23.25	281	.02	.01	.01	21.
1.01	11.00	132	.07	.06	.01	91.	1.01	23.30	282	.02	.01	.01	21.
1.01	11.05	133	.07	.06	.01	91.	1.01	23.35	283	.02	.01	.01	21.
1.01	11.10	134	.07	.06	.01	91.	1.01	23.40	284	.02	.01	.01	21.
1.01	11.15	135	.07	.06	.01	91.	1.01	23.45	285	.02	.01	.01	21.
1.01	11.20	136	.07	.06	.01	91.	1.01	23.50	286	.02	.01	.01	21.
1.01	11.25	137	.07	.06	.01	91.	1.01	23.55	287	.02	.01	.01	21.
1.01	11.30	138	.07	.06	.01	91.	1.02	0.00	288	.02	.01	.01	21.
1.01	11.35	139	.07	.06	.01	91.	1.02	.05	289	0.00	0.00	0.00	21.
1.01	11.40	140	.07	.06	.01	91.	1.02	.10	290	0.00	0.00	0.00	19.
1.01	11.45	141	.07	.06	.01	91.	1.02	.15	291	0.00	0.00	0.00	12.
1.01	11.50	142	.07	.06	.01	91.	1.02	.20	292	0.00	0.00	0.00	6.
1.01	11.55	143	.07	.06	.01	91.	1.02	.25	293	0.00	0.00	0.00	3.
1.01	12.00	144	.07	.06	.01	91.	1.02	.30	294	0.00	0.00	0.00	2.
1.01	12.05	145	.20	.20	.01	91.	1.02	.35	295	0.00	0.00	0.00	1.
1.01	12.10	146	.20	.20	.01	111.	1.02	.40	296	0.00	0.00	0.00	0.
1.01	12.15	147	.20	.20	.01	176.	1.02	.45	297	0.00	0.00	0.00	0.
1.01	12.20	148	.20	.20	.01	231.	1.02	.50	298	0.00	0.00	0.00	0.
1.01	12.25	149	.20	.20	.01	260.	1.02	.55	299	0.00	0.00	0.00	0.
1.01	12.30	150	.20	.20	.01	275.	1.02	1.00	300	0.00	0.00	0.00	0.
									SUM	31.46	29.30	2.16	43505.
										(799.)	(744.)	(55.)	(1231.92)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2263.	487.	151.	145.	43538.
CMS	64.	14.	4.	4.	1233.
INCHES		23.83	29.61	29.61	29.61
MM		605.26	751.98	751.98	751.98
AC-FT		241.	300.	300.	300.
THOUS CU M		298.	370.	370.	370.

HYDROGRAPH AT STA 7 FOR PLAN 1, RTIO 1

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	1.	4.	7.	9.	10.	11.
11.	11.	11.	19.	45.	67.	79.	85.	88.	90.
90.	91.	91.	91.	91.	91.	91.	91.	91.	91.
91.	91.	91.	91.	91.	91.	91.	91.	91.	91.
91.	91.	91.	91.	91.	91.	91.	91.	91.	91.
91.	91.	91.	91.	91.	91.	91.	91.	91.	91.
91.	91.	91.	91.	91.	91.	91.	91.	91.	91.
91.	91.	91.	91.	91.	111.	176.	231.	260.	275.
282.	287.	289.	290.	291.	291.	291.	297.	317.	333.

342.	346.	348.	350.	350.	351.	351.	351.	351.	360.
389.	414.	427.	433.	437.	439.	440.	440.	441.	441.
441.	423.	393.	434.	511.	640.	911.	1590.	2263.	2040.
1586.	1198.	912.	729.	588.	507.	461.	434.	421.	415.
413.	411.	411.	411.	411.	402.	374.	348.	335.	328.
325.	323.	322.	321.	321.	321.	321.	291.	193.	111.
68.	46.	35.	28.	25.	23.	22.	21.	21.	21.
21.	21.	21.	21.	21.	21.	21.	21.	21.	21.
21.	21.	21.	21.	21.	21.	21.	21.	21.	21.
21.	21.	21.	21.	21.	21.	21.	21.	21.	21.
21.	21.	21.	21.	21.	21.	21.	21.	21.	21.
21.	21.	21.	21.	21.	21.	21.	21.	21.	21.
21.	21.	21.	21.	21.	21.	21.	21.	21.	19.
12.	6.	3.	2.	1.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2263.	487.	151.	145.	43538.
CMS	64.	14.	4.	4.	1233.
INCHES		23.83	29.61	29.61	29.61
MM		605.26	751.98	751.98	751.98
AC-FT		241.	300.	300.	300.
THOUS CU M		298.	370.	370.	370.

HYDROGRAPH AT STA 7 FOR PLAN 1, RTIO 2

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	2.	4.	5.	5.	5.
6.	6.	6.	10.	23.	34.	39.	42.	44.	45.
45.	45.	46.	46.	46.	46.	46.	46.	46.	46.
46.	46.	46.	46.	46.	46.	46.	46.	46.	46.
46.	46.	46.	46.	46.	46.	46.	46.	46.	46.
46.	46.	46.	46.	46.	46.	46.	46.	46.	46.
46.	46.	46.	46.	46.	46.	46.	46.	46.	46.
46.	46.	46.	46.	46.	46.	46.	46.	46.	46.
46.	46.	46.	46.	46.	46.	46.	46.	46.	46.
46.	46.	46.	46.	46.	56.	88.	115.	130.	137.
141.	143.	144.	145.	145.	146.	146.	149.	158.	166.
171.	173.	174.	175.	175.	175.	175.	175.	175.	180.
195.	207.	213.	217.	218.	219.	220.	220.	220.	220.
220.	212.	197.	217.	255.	320.	455.	795.	1131.	1040.
793.	599.	456.	365.	294.	254.	231.	217.	211.	208.
206.	206.	206.	205.	205.	201.	186.	174.	168.	164.
163.	161.	161.	161.	161.	160.	160.	145.	97.	56.
34.	23.	17.	14.	12.	11.	11.	11.	11.	11.
11.	11.	11.	11.	11.	11.	11.	11.	11.	11.
11.	11.	11.	11.	11.	11.	11.	11.	11.	11.
11.	11.	11.	11.	11.	11.	11.	11.	11.	11.
11.	11.	11.	11.	11.	11.	11.	11.	11.	11.
11.	11.	11.	11.	11.	11.	11.	11.	11.	11.
11.	11.	11.	11.	11.	11.	11.	11.	11.	10.
6.	3.	2.	1.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1131.	243.	76.	73.	21769.
CMS	32.	7.	2.	2.	616.

PMF FLOOD ROUTING

INCHES	11.91	14.80	14.80	14.80	
MM	302.63	375.99	375.99	375.99	
AC-FT	121.	150.	150.	150.	
THOUS CU M	149.	185.	185.	185.	

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HYDROGRAPH ROUTING

ROUTE HYDROGRAPH THROUGH RUSSEL SANDIPER LAKE DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
7	1	0	0	2	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-600.	-1

STAGE	600.0 609.5	602.0 611.0	603.2 613.9	603.9	604.6	605.3	606.0	606.7	607.3	608.0
FLOW	0. 8531.	42. 13678.	95. 25970.	195.	335.	510.	719.	1450.	2573.	4184.
CAPACITY=	0.	39.	52.	75.	214.	566.				
ELEVATION=	578.	600.	603.	606.	620.	640.				

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
600.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
606.0	0.0	0.0	0.

STATION 7, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	1.	1.
1.	1.	2.	2.	3.	4.	6.	8.	10.	12.
14.	16.	18.	20.	22.	24.	26.	27.	29.	31.
32.	34.	35.	37.	38.	39.	41.	42.	45.	47.
50.	52.	54.	56.	58.	60.	61.	63.	64.	65.
67.	68.	69.	70.	71.	72.	72.	73.	74.	75.
76.	76.	77.	78.	78.	79.	79.	80.	80.	81.
81.	82.	82.	83.	83.	83.	84.	84.	84.	85.
85.	85.	85.	86.	86.	87.	89.	94.	114.	135.

155.	173.	189.	206.	222.	235.	246.	255.	265.	276.
288.	299.	308.	316.	322.	328.	332.	336.	339.	343.
351.	363.	377.	389.	400.	409.	417.	422.	427.	430.
433.	432.	427.	424.	435.	469.	548.	776.	1407.	1963.
1866.	1511.	1245.	1012.	818.	692.	633.	581.	538.	505.
483.	466.	453.	443.	435.	428.	418.	405.	389.	376.
364.	354.	347.	341.	336.	333.	331.	326.	310.	280.
243.	208.	181.	160.	142.	125.	111.	99.	93.	90.
87.	84.	81.	78.	76.	73.	71.	69.	67.	65.
63.	60.	58.	56.	54.	53.	51.	50.	48.	47.
45.	44.	43.	42.	41.	41.	40.	40.	39.	39.
38.	38.	38.	37.	37.	36.	36.	35.	35.	35.
34.	34.	34.	33.	33.	33.	32.	32.	32.	32.
31.	31.	31.	31.	30.	30.	30.	30.	29.	29.
29.	28.	28.	27.	26.	26.	25.	24.	24.	23.

STORAGE

39.	39.	39.	39.	39.	39.	39.	39.	39.	39.
39.	39.	39.	39.	39.	39.	39.	39.	39.	39.
39.	39.	39.	39.	39.	39.	39.	39.	39.	39.
39.	39.	39.	39.	39.	39.	39.	39.	39.	39.
39.	39.	39.	39.	39.	39.	39.	39.	39.	39.
39.	39.	39.	39.	39.	39.	39.	39.	39.	39.
39.	39.	39.	39.	39.	39.	39.	39.	39.	39.
39.	39.	39.	39.	39.	40.	40.	41.	41.	42.
42.	43.	43.	44.	44.	45.	45.	46.	46.	47.
47.	47.	48.	48.	48.	49.	49.	50.	50.	50.
50.	51.	51.	51.	51.	52.	52.	52.	52.	52.
53.	53.	53.	53.	53.	53.	54.	54.	54.	54.
54.	54.	54.	54.	54.	55.	55.	55.	55.	55.
55.	55.	55.	55.	55.	55.	55.	55.	55.	55.
55.	55.	56.	56.	56.	56.	56.	57.	58.	59.
60.	61.	61.	62.	62.	63.	63.	64.	64.	64.
65.	65.	65.	66.	66.	66.	66.	66.	66.	66.
67.	67.	67.	68.	68.	68.	68.	68.	68.	69.
69.	69.	68.	68.	69.	70.	71.	75.	81.	85.
84.	82.	80.	78.	76.	74.	73.	72.	71.	70.
70.	69.	69.	69.	69.	69.	68.	68.	68.	67.
67.	67.	66.	66.	66.	66.	66.	66.	65.	64.
63.	62.	61.	60.	59.	58.	58.	57.	57.	56.
56.	55.	55.	54.	54.	54.	53.	53.	53.	52.
52.	52.	52.	51.	51.	51.	51.	50.	50.	50.
50.	50.	50.	49.	49.	49.	49.	49.	49.	49.
49.	48.	48.	48.	48.	48.	48.	48.	48.	48.
48.	47.	47.	47.	47.	47.	47.	47.	47.	47.
47.	47.	47.	47.	46.	46.	46.	46.	46.	46.
46.	46.	46.	46.	45.	45.	45.	45.	45.	45.

STAGE

600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0
600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0
600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0
600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0
600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0
600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0
600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0
600.1	600.1	600.1	600.1	600.1	600.2	600.3	600.4	600.5	600.6
600.7	600.8	600.9	601.0	601.0	601.1	601.2	601.3	601.4	601.5
601.5	601.6	601.7	601.7	601.8	601.9	601.9	602.0	602.1	602.1
602.2	602.2	602.3	602.3	602.4	602.4	602.4	602.5	602.5	602.5

602.6	602.6	602.6	602.6	602.7	602.7	602.7	602.7	602.7	602.8
602.8	602.8	602.8	602.8	602.8	602.9	602.9	602.9	602.9	602.9
602.9	602.9	602.9	602.9	603.0	603.0	603.0	603.0	603.0	603.0
603.0	603.0	603.0	603.0	603.0	603.0	603.1	603.2	603.4	603.5
603.7	603.8	603.9	604.0	604.1	604.1	604.2	604.2	604.3	604.3
604.4	604.5	604.5	604.5	604.6	604.6	604.6	604.6	604.7	604.7
604.7	604.7	604.8	604.9	604.9	604.9	605.0	605.0	605.0	605.0
605.0	605.0	605.0	605.0	605.0	605.2	605.4	606.0	606.6	607.0
606.9	606.7	606.5	606.3	606.1	605.9	605.7	605.5	605.4	605.3
605.2	605.1	605.1	605.1	605.0	605.0	605.0	604.9	604.9	604.8
604.8	604.7	604.7	604.7	604.6	604.6	604.6	604.6	604.5	604.4
604.2	604.0	603.8	603.7	603.6	603.4	603.3	603.3	603.2	603.1
603.0	603.0	602.9	602.8	602.8	602.7	602.7	602.6	602.6	602.5
602.5	602.4	602.4	602.3	602.3	602.2	602.2	602.2	602.1	602.1
602.1	602.0	602.0	602.0	602.0	601.9	601.9	601.9	601.9	601.9
601.8	601.8	601.8	601.8	601.7	601.7	601.7	601.7	601.7	601.7
601.6	601.6	601.6	601.6	601.6	601.6	601.5	601.5	601.5	601.5
601.5	601.5	601.5	601.5	601.4	601.4	601.4	601.4	601.4	601.4
601.4	601.3	601.3	601.3	601.3	601.2	601.2	601.2	601.1	601.1

PEAK OUTFLOW IS 1963. AT TIME 15.85 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1963.	475.	148.	142.	42674.
CMS	56.	13.	4.	4.	1208.
INCHES		23.27	29.02	29.02	29.02
MM		591.04	737.06	737.06	737.06
AC-FT		236.	294.	294.	294.
THOUS CU M		291.	363.	363.	363.

MAXIMUM STORAGE = 85.

ONE-HALF PMF FLOOD ROUTING

DVN

STATION 7, PLAN 1, RATIO 2

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1.	1.	1.	1.	1.	2.	3.	4.	5.	6.
7.	8.	9.	10.	11.	12.	13.	14.	14.	15.
16.	17.	18.	18.	19.	20.	20.	21.	22.	22.
23.	24.	24.	25.	25.	26.	26.	27.	27.	28.
28.	29.	29.	30.	30.	30.	31.	31.	32.	32.
32.	33.	33.	33.	34.	34.	34.	35.	35.	35.
35.	36.	36.	36.	36.	37.	37.	37.	37.	38.
38.	38.	38.	38.	39.	39.	40.	41.	45.	50.
55.	59.	64.	67.	71.	74.	77.	80.	84.	87.
91.	94.	104.	114.	122.	130.	136.	141.	146.	150.
156.	162.	169.	175.	181.	186.	191.	195.	200.	204.
207.	209.	208.	208.	213.	227.	258.	328.	479.	645.
725.	713.	661.	590.	516.	457.	406.	362.	328.	306.
287.	271.	259.	249.	240.	233.	226.	217.	208.	200.
194.	189.	185.	182.	179.	176.	174.	171.	164.	152.
137.	122.	108.	95.	91.	88.	84.	81.	78.	75.
72.	69.	67.	64.	62.	59.	56.	54.	52.	49.
47.	45.	44.	42.	41.	40.	40.	39.	38.	37.
37.	36.	35.	35.	34.	33.	33.	32.	32.	31.
31.	30.	30.	29.	29.	28.	28.	27.	27.	26.
26.	26.	25.	25.	24.	24.	24.	23.	23.	23.
22.	22.	22.	21.	21.	21.	21.	20.	20.	20.
20.	19.	19.	18.	18.	17.	17.	16.	16.	16.

STORAGE

39.	39.	39.	39.	39.	39.	39.	39.	39.	39.
39.	39.	39.	39.	39.	39.	39.	39.	39.	39.
39.	39.	39.	39.	39.	39.	39.	39.	39.	39.
39.	39.	39.	39.	39.	39.	39.	39.	39.	39.
39.	39.	39.	39.	39.	39.	39.	39.	39.	39.
39.	39.	39.	39.	39.	39.	39.	39.	39.	39.
39.	39.	39.	39.	39.	39.	39.	39.	39.	39.
39.	39.	39.	39.	39.	39.	39.	40.	40.	40.
40.	41.	41.	41.	41.	42.	42.	42.	42.	43.
43.	43.	43.	43.	44.	44.	44.	44.	44.	44.
45.	45.	45.	45.	45.	45.	45.	46.	46.	46.
46.	46.	46.	46.	46.	46.	47.	47.	47.	47.
47.	47.	47.	47.	47.	47.	47.	48.	48.	48.
48.	48.	48.	48.	48.	48.	48.	48.	48.	48.
48.	48.	48.	49.	49.	49.	49.	49.	50.	50.
51.	52.	52.	53.	53.	54.	54.	55.	55.	56.
56.	57.	57.	58.	58.	59.	59.	59.	59.	60.
60.	60.	60.	61.	61.	61.	61.	62.	62.	62.
62.	62.	62.	62.	62.	63.	64.	66.	70.	73.
75.	75.	74.	72.	71.	69.	68.	67.	66.	65.
65.	64.	64.	63.	63.	63.	63.	62.	62.	62.

62.	61.	61.	61.	61.	61.	61.	60.	60.	60.
59.	58.	58.	57.	56.	56.	55.	55.	54.	54.
54.	53.	53.	52.	52.	52.	51.	51.	51.	50.
50.	50.	50.	49.	49.	49.	49.	49.	48.	48.
48.	48.	48.	48.	47.	47.	47.	47.	47.	47.
47.	46.	46.	46.	46.	46.	46.	46.	46.	45.
45.	45.	45.	45.	45.	45.	45.	45.	45.	44.
44.	44.	44.	44.	44.	44.	44.	44.	44.	44.
44.	44.	43.	43.	43.	43.	43.	43.	43.	43.

STAGE

600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0
600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0
600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0
600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0
600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0
600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0
600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0
600.0	600.0	600.0	600.0	600.1	600.1	600.1	600.2	600.2	600.3
600.3	600.4	600.4	600.5	600.5	600.6	600.6	600.6	600.7	600.7
600.8	600.8	600.8	600.9	600.9	600.9	601.0	601.0	601.0	601.1
601.1	601.1	601.1	601.2	601.2	601.2	601.3	601.3	601.3	601.3
601.3	601.4	601.4	601.4	601.4	601.4	601.5	601.5	601.5	601.5
601.5	601.6	601.6	601.6	601.6	601.6	601.6	601.6	601.7	601.7
601.7	601.7	601.7	601.7	601.7	601.7	601.8	601.8	601.8	601.8
601.8	601.8	601.8	601.8	601.8	601.9	601.9	602.0	602.1	602.2
602.3	602.4	602.5	602.6	602.7	602.7	602.8	602.9	603.0	603.0
603.1	603.2	603.3	603.4	603.4	603.5	603.5	603.6	603.6	603.6
603.7	603.7	603.8	603.8	603.8	603.9	603.9	603.9	604.0	604.0
604.0	604.0	604.0	604.0	604.0	604.1	604.3	604.6	605.2	605.8
606.0	606.0	605.8	605.6	605.3	605.1	604.9	604.7	604.6	604.5
604.4	604.3	604.3	604.2	604.2	604.1	604.1	604.0	604.0	604.0
603.9	603.9	603.9	603.8	603.8	603.8	603.8	603.8	603.7	603.6
603.5	603.4	603.3	603.2	603.1	603.1	603.0	602.9	602.8	602.8
602.7	602.6	602.6	602.5	602.5	602.4	602.3	602.3	602.2	602.2
602.1	602.1	602.0	602.0	602.0	601.9	601.9	601.8	601.8	601.8
601.7	601.7	601.7	601.7	601.6	601.6	601.6	601.5	601.5	601.5
601.5	601.4	601.4	601.4	601.4	601.3	601.3	601.3	601.3	601.3
601.2	601.2	601.2	601.2	601.2	601.1	601.1	601.1	601.1	601.1
601.1	601.1	601.0	601.0	601.0	601.0	601.0	601.0	601.0	600.9
600.9	600.9	600.9	600.9	600.8	600.8	600.8	600.8	600.8	600.7

PEAK OUTFLOW IS 725. AT TIME 15.92 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	725.	228.	74.	71.	21185.
CMS	21.	6.	2.	2.	600.
INCHES		11.14	14.41	14.41	14.41
MM		282.95	365.90	365.90	365.90
AC-FT		113.	146.	146.	146.
THOUS CU M		139.	180.	180.	180.

MAXIMUM STORAGE = 75.

SUMMARY OF PMF AND ONE-HALF PMF FLOOD ROUTING

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 1.00	RATIO 2 .50
HYDROGRAPH AT	7 (.49)	.19	1 (	2263. 64.07)(	1131. 32.03)(
ROUTED TO	7 (.49)	.19	1 (	1963. 55.59)(	725. 20.54)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	600.00	600.00	606.00
STORAGE	39.	39.	75.
OUTFLOW	0.	0.	730.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	606.96	.96	85.	1965.	.67	15.83	0.00
.50	606.00	0.00	75.	725.	0.00	15.92	0.00

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  3 AUG 78
**********
```

PERCENT OF PMF FLOOD ROUTING
EQUAL TO SPILLWAY CAPACITY

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT	7
ROUTE HYDROGRAPH TO	7
END OF NETWORK	

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION  JULY 1978
  LAST MODIFICATION  3 AUG 78
**********

RUN  DATE= 78/10/26.
     TIME= 08.35.15.
```

DAM SAFETY INSPECTION - MISSOURI
RUSSEL SANDIFER Dam
PERCENT OF PMF DETERMINATION AND ROUTING

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	5	0	0	0	0	0	4	0

JOPER	NRT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 9 LRTIO= 1

RTIOS=	.50	.51	.52	.53	.54	.55	.56	.57	.58

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INPUT PMP INDEX PRECIPITATION AND RATIOS, INPUT SCS UNI

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
7	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	-1	.19	0.00	.19	1.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	24.20	100.00	120.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	.85	.07	0.00	0.00

RECESSION DATA

STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

0

HO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	HO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	31.46	29.30	2.16	43505.
										(799.)(744.)(55.)(1231.92)			

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE HYDROGRAPH THRUUGH RUSSEL SANDIFER LAKE DAM

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
7	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-600.	-1

STAGE	600.0	602.0	603.2	603.9	604.6	605.3	606.0	606.7	607.3	608.0
	609.5	611.0	613.9							
FLOW	0.	42.	95.	195.	335.	510.	719.	1450.	2573.	4184.
	8531.	13678.	25970.							
CAPACITY=	0.	39.	52.	75.	214.	566.				
ELEVATION=	578.	600.	603.	606.	620.	640.				

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
600.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
606.0	0.0	0.0	0.

PEAK OUTFLOW IS 725. AT TIME 15.92 HOURS

PEAK OUTFLOW IS 760. AT TIME 15.92 HOURS

PEAK OUTFLOW IS 792. AT TIME 15.92 HOURS

PEAK OUTFLOW IS 824. AT TIME 15.92 HOURS

PEAK OUTFLOW IS 856. AT TIME 15.92 HOURS

PEAK OUTFLOW IS 883. AT TIME 15.92 HOURS

PEAK OUTFLOW IS 907. AT TIME 15.92 HOURS

PEAK OUTFLOW IS 930. AT TIME 15.92 HOURS

PEAK OUTFLOW IS 954. AT TIME 15.92 HOURS

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS								
				RATIO 1 .50	RATIO 2 .51	RATIO 3 .52	RATIO 4 .53	RATIO 5 .54	RATIO 6 .55	RATIO 7 .56	RATIO 8 .57	RATIO 9 .58
HYDROGRAPH AT	7	.19	1	1131.	1154.	1177.	1199.	1222.	1244.	1267.	1290.	1312.
	(	.49)	(	32.03)(	32.67)(	33.32)(	33.96)(	34.60)(	35.24)(	35.88)(	36.52)(	37.16)
ROUTED TO	7	.19	1	725.	760.	792.	824.	856.	883.	907.	930.	954.
	(	.49)	(	20.54)(	21.52)(	22.44)(	23.35)(	24.24)(	25.01)(	25.68)(	26.35)(	27.02)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	600.00	600.00	606.00
STORAGE	39.	39.	75.
OUTFLOW	0.	0.	730.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	606.00	0.00	75.	725.	0.00	15.92	0.00
.51	606.03	.03	75.	760.	.17	15.92	0.00
.52	606.06	.06	76.	792.	.17	15.92	0.00
.53	606.09	.09	76.	824.	.17	15.92	0.00
.54	606.12	.12	76.	856.	.17	15.92	0.00
.55	606.14	.14	76.	883.	.25	15.92	0.00
.56	606.16	.16	77.	907.	.25	15.92	0.00
.57	606.18	.18	77.	930.	.25	15.92	0.00
.58	606.21	.21	77.	954.	.33	15.92	0.00